Author	Year	Title	Document Type	Journal/Book Title/Publisher	Pages (and Volume(issue) if applicable)
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ADFG	2007	Brown bear management report of survey-inventory activities 1 July 2004 - 30 June 2006	Report	ADFG, Division of Wildlife Conservation	348
ADFG	2007	Caribou management report of survey-inventory activities 1 July 2004-30 June 2006	Report	ADFG, Division of Wildlife Conservation	316
ADFG	2007	Economic impacts and contributions of sportfishing in Alaska	Government Document	ADFG, Division of Sport Fish	12
ADFG	2007	Furbearer management report of survey-inventory activities	Report	ADFG, Division of Wildlife Conservation	352
ADFG	2008	Anadromous Waters Atlas Naknek Index	Map	ADFG, Division of Sport Fish	1

ADFG	2008	Black bear management report of survey-inventory activities 1 July 2004 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation	256
ADFG	2008	Moose management report of survey-inventory activities 1 July 2005 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation	696
ADFG	2009	Anadromous Water Atlas Dillingham Index	Map	ADFG, Division of Sport Fish	1
ADFG	2009	Anadromous Waters Atlas Iliamna Index	Map	ADFG, Division of Sport Fish	1
ADFG	2009	Anadromous Waters Atlas Lake Clark Index	Map	ADFG, Division of Sport Fish	1
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ADFG	2010	Bristol Bay critical habitat areas (Egegik, Pilot Point, Cinder River, Port Heiden, and Port Moller) management plan	Government Document	ADFG, Division of Habitat and Division of Wildlife Conservation	194
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DCRA	2010	Community Information Summaries (CIS): Ekwok	Web Page	Alaska Community Database	3
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DCRA	2010	Community Information Summaries (CIS): Iliamna	Web Page	Alaska Community Database	3
DCRA	2010	Community Information Summaries (CIS): King Salmon	Web Page	Alaska Community Database	3
DCRA	2010	Community Information Summaries (CIS): Kokhanok	Web Page	Alaska Community Database	3
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DCRA	2010	Community Information Summaries (CIS): Naknek	Web Page	Alaska Community Database	3
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DCRA	2010	Community Information Summaries (CIS): Newhalen	Web Page	Alaska Community Database	3
DCRA	2010	Community Information Summaries (CIS): Nondalton	Web Page	Alaska Community Database	3
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Abstract
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The Bristol Bay critical habitat areas (CHAs) are co-managed by the Alaska Department of Fish and Game (ADFG) in accordance with Alaska Statute 16.20.520-530, and the Alaska Department of Natural Resources (DNR) per AS 38.05. The purpose of the Bristol Bay Critical Habitat Areas Management Plan is to provide consistent, long-range guidance in managing the five CHAs. ADFG has undertaken this comprehensive planning process in order to establish guidelines, policies, and regulations for management of fish and wildlife, habitat, and current and future activities that affect them on the CHAs. This draft plan presents management goals for the CHAs and their resources, and identifies polices to be used in determining whether proposed activities are compatible with the protection of fish and wildlife, their habitats, and public use of the
New regulations based on wild trout management policies now apply to popular rainbow trout waters in Southwest Alaska. These regulations were passed by the Alaska Board of Fisheries after two years of public meetings and involvement by anglers, guides, lodge owners, area residents, and the department. Management policies were adopted by the board to sustain quality wild stock rainbow populations while providing a variety of sport fishing opportunities through establishment of special areas. Also, the new board policies

This plan guides state land management by the Department of Natural Resources in the Nushagak and Mulchatna drainages and guides coastal consistency review. This plan: 1) identifies goals, management intent, and public use sites for 25 management units in the planning area; 2) specifies management policies for long-term uses (uses that take place at one site on state land for longer than 14 consecutive days), including permanent and temporary facilities, trapping cabins, boat storage, airstrip development, docks, and other uses, and specifies where these uses may be allowed and where they are prohibited; 3) includes guidelines that provide specific management direction for the 25 management units and public use sites; and 4) includes implementation information and

Alaska's immense size and northerly position make it a critical region for breeding and migrating shorebirds. In fact, Alaska provides breeding habitat for more shorebird species than any other state in the US. Seventy-three species of shorebirds have occurred in Alaska; 37 of them, including several unique Beringian species and Old World subspecies, regularly breed in the region. Most of these species migrate south of the US-Mexico border and one-third migrate to South America or Oceania. Concentrations of shorebirds at several coastal staging and migratory stopover sites exceed one million birds; on the Copper River Delta alone, five to eight million shorebirds stop to forage and rest each spring. Shorebirds worldwide have suffered dramatic population declines in the last decade. Using the species prioritization process developed for the US National Shorebird Plan, we incorporated new population estimates, updated threats, and identified 20 taxa of shorebirds of high conservation concern in Alaska. All species of concern tend to have small global population sizes or limited breeding distributions. Seasonal occurrence of priority species was examined within the geographic context of Alaska's five Bird Conservation Regions (BCRs). Most priority species, particularly breeding species, occur in the Western Alaska and Arctic Coastal Plain BCRs. Southern regions of the Northwest Interior Forest and the Northern Pacific Rainforest BCRs are primarily used by shorebirds during migration and winter. The Aleutian/Bering Sea Islands BCR is also an important wintering area for shorebirds. Around the world, loss of wetland habitat represents the greatest threat to shorebird populations. Nonbreeding and migratory stopover areas outside of Alaska that are important to the state's shorebirds are being altered by humans at an immense scale, primarily through drainage and reclamation of coastal wetlands. Critical shorebird habitats are further threatened worldwide by changes predicted to occur through ancillary effects of global climate change, particularly rising of sea level and drying of continental wetlands. Shorebird habitats in Alaska are still relatively intact, but interior wetlands important for breeding are already showing evidence of drying, and coastal areas are being altered by increasingly intense storms. Shorebird habitats in Alaska face other, more local threats, particularly from energy and mining development in the

The Late Cretaceous (90 Ma) Pebble Cu-Au-Mo porphyry deposit is located within the southern Kahiltna terrane, which is comprised of the Chilikadrotna Greenstone and the Koksetna River sequence. Near the Pebble deposit, the Chilikadrotna Greenstone marks the northwest border of the southern Kahiltna terrane, and the Koksetna River flysch sequence is the host for mineralization at Pebble. Throughout the world, porphyry deposits are found in clusters associated with multiple intrusive events, typically, if not always, subduction-related, thereby suggesting the southern Kahiltna terrane is potentially favourable for other porphyry occurrences. Our integration of multiple geoscientific data layers has revealed that the world-class Pebble deposit may similarly be accompanied by additional porphyry-style mineralization elsewhere in the southern Kahiltna terrane. Delineation of watersheds, derived from processing of digital elevation data, provided an effective framework for predicting favourable areas for mineralization. Beyond analysis of individual data layers of geochemistry, geology, geophysics, and remote sensing, geographic information systems (GIS) applications facilitated an

The effects of acidification in lotic systems are not well documented. Spatial and temporal variability of habitat and water quality complicate the evaluation of acidification effects in streams and rivers. The Neversink River in the Catskill Mountains of southeastern New York, the tributaries of which vary from well buffered to severely acidified, provided an opportunity to investigate the extent and magnitude of acidification effects on fish communities of headwater systems. Composition of fish communities, water quality, stream hydrology, stream habitat, and physiographic factors were characterized from 1991 to 1995 at 16 first- to fourth-order sites in the basin. Correlation and regression analyses were used to develop empirical models and to assess the relations among fish species richness, total fish density, and total fish biomass and environmental variables. Chronic and episodic acidification and elevated concentrations of inorganic monomeric aluminum were common, and fish populations were rare or absent from several sites in the upper reaches of the basin; as many as six fish species were collected from sites in the lower reaches of the basin. Species distributions and species richness were most highly related to stream pH, acid-neutralizing capacity (ANC), inorganic monomeric aluminum (Al_{im}), calcium $(Ca)^{2+}$, and potassium $(K)^{+}$* concentrations, site elevation, watershed drainage area, and water temperature. Fish density was most highly related to stream pH, Al_{im}, ANC, K^+, Ca^{2+}, and magnesium $(Mg)^{2+}$ concentrations. Fish biomass, unlike species richness and fish density, was most highly related to physical habitat characteristics, water temperature, and concentrations of Mg^{2+} and silicon. Acidity characteristics were of secondary importance to fish biomass

The sublethal effects of copper on the sensory physiology of juvenile coho salmon (*Oncorhynchus kisutch*) were evaluated. In vivo field potential recordings from the olfactory epithelium (electro-olfactograms) were used to measure the impacts of copper on the responses of olfactory receptor neurons to natural odorants (L-serine and taurocholic acid) and an odorant mixture (L-arginine, L-aspartic acid, L-leucine, and L-serine) over a range of stimulus concentrations. Increases in copper impaired the neurophysiological response to all odorants within 10 min of exposure. The inhibitory effects of copper (1.0 - 20.0 μg/L) were dose-dependent and they were not influenced by water hardness. Toxicity thresholds for the different receptor pathways were determined by using the benchmark dose method and found to be similar (a 2.3 - 3.0 μg/L increase in total dissolved copper over background). Collectively, examination of these data

The abandoned copper mine at Britannia Beach, British Columbia, has been releasing acid mine drainage (AMD) into Howe Sound for many years. To assess the impacts of AMD on juvenile salmonids in the Britannia Creek estuary, we compared fish abundance, distribution, and survival at contaminated sites near the creek with uncontaminated areas in Howe Sound. Water quality near Britannia Creek was poor, particularly in spring when dissolved Cu exceeded $1.0\ mg \cdot L^{-1}$ and pH was less than 6. Beach seine surveys conducted during April–August 1997 and March–May 1998 showed that chum salmon (*Oncorhynchus keta*) fry abundance was significantly lower near Britannia Creek mouth ($0–1.2 \cdot 100\ m^{-2}$) than in reference areas ($11.5–31.4 \cdot 100\ m^{-2}$). Laboratory bioassays confirmed that AMD from Britannia Mine was toxic to juvenile chinook (*Oncorhynchus tshawytscha*) and chum salmon (96-h LC50 = 0.7–29.7% in fresh- water and 12.6–62.2% in 10 ppt water). Chinook salmon smolts transplanted to surface cages near Britannia Creek experienced 100% mortality within 2 days. These

Bristol Bay and its islands, the embayments, lagoons, and other estuaries along the north side of the Alaska Peninsula, and the nesting cliffs on the north shore, are seasonally important to vast numbers of seabirds, waterfowl, and shorebirds that breed, summer, winter, or stopover there during migration. This productive southeast corner of the Bering Sea is also used by sea otters and several species of pinnipeds and cetaceans, and is the site of the worlds largest salmon fishery. Petroleum development is planned for this area and, judging from the past history of numerous oil spills in nearby Cook Inlet, could have deleterious effects on this rich fauna. This possibility prompted investigations of the migratory birds, including the pelagic species, that could provide the year-round information on distribution and numbers necessary to protect birds from the possible hazards of petroleum development and shipping. A part of that information is provided by the observations on distribution and relative numbers of pelagic birds made in a section of Bristol Bay during July and August 1969, and reported on in this paper. Data on pelagic birds from the Bering Sea region is limited, and even less is published about birds within Bristol Bay. Jaques (1930) provided annotations on the birds he observed in and between Unalaska and Port Moller during the early summer of 1928. Shuntov (1961) surveyed populations of birds summering in the shallow portion of the eastern Bering Sea but west of Bristol Bay. King and McKnight (1969) made aerial surveys of the pelagic birds within 12 miles of the Bristol Bay coastline in October. Arnold (1948) reported on the distribution of birds in the North Pacific from Kodiak Island to Unalaska Island and in the Bering Sea from Unalaska Island to Attu Island between 18 June and 16 September 1944. Kuroda (1955) reported on the birds seen at sea in the vicinity of the Kuril Islands and near the western end of the Aleutian Islands. Shuntov (1966) and Irving et al. (1970) reported on the wintering birds of the Bering Sea. Unanalyzed data on birds observed in the Bering Sea are published with the oceanographic and fisheries records of the RV Osharo Maru (Hokkaido University 1957-68). Osgood (1904), Murie (1959), and Gabrielson and Lincoln (1959) summarized the information on birds of the lands bordering Bristol Bay. Dall (1873) and Cahn (1947) described the birds on and about Unalaska Island, the westernmost point included within

Protection of Washington State's salmonids requires that transportation officials consider the effect of suspended sediments released into streams during transportation projects. Many state and provincial criteria are based on a threshold of exceedance for background levels of turbidity. However, determining natural background levels of turbidity is a difficult endeavor. The inconsistent correlation between turbidity measurements and mass of suspended solids, as well as the difficulty in achieving repeatability using turbidimeters contributes to concerns that turbidity may not be a consistent and reliable tool determining the effects of suspended solids on salmonids. Other factors, such as life stage, time of year, size and angularity of sediment, availability of off-channel and tributary habitat, and composition of sediment may be more telling in determining the effect of sediment on salmonids in Northwestern rivers. For short-term construction projects, operators will need to measure background turbidities on a case by case basis to determine if they are exceeding regulations. However, transportation projects may also produce long-term, chronic effects. To adequately protect salmonids during their freshwater residence, TSS data on physiological, behavioral, and habitat effects should be viewed in a layer context

This study quantitatively evaluated the relationships among As, Co, and Cu concentrations in exposure media (surface water, sediment, and *aufwuchs*), As, Co, and Cu concentrations in aquatic macroinvertebrates, and invertebrate community structure in a mine-affected stream. Concentrations of As, Co, and Cu were significantly elevated in both exposure media and invertebrate tissue downstream from the mine. Copper in invertebrates was significantly correlated only with Cu in *aufwuchs*, and Co in invertebrates was significantly correlated only with dissolved Co in water, suggesting different mechanisms of invertebrate accumulation for these two metals. The invertebrate community was severely affected downstream from the mine, with a loss of metals-sensitive species and reductions in both total biomass and number of species. Total abundance was not affected. Principal components analysis was performed on the invertebrate community data to develop a simplified description of community response to mine inputs. Based on this index, metal concentrations in invertebrates were poor

The territorial, gill-flaring, and feeding behavior of juvenile coho salmon (*Oncorhynchus kisutch*) in a laboratory stream was disrupted by short-term exposure to suspended sediment pulses. At the higher turbidities tested (30 and 60 nephelometric turbidity units (NTU)), dominance hierarchies broke down, territories were not defended, and gill flaring occurred more frequently. Only after return to lower turbidities (0-20 NTU) was social organization reestablished. The reaction distance of the fish to adult brine shrimp decreased significantly in turbid water (30 and 60 NTU) as did capture success per strike and the percentage of prey ingested. Implications of these behavioral modifications
Some water quality standards established by the states permit only minor increases in suspended sediment when background turbidity is low, allow greater absolute increases as background levels rise, and do not consider acclimation of stream biota to high turbidity. Juvenile coho salmon (*Oncorhynchus kisutch*) were subjected to experimentally elevated concentrations of suspended sediment and did not avoid moderate turbidity increases when background levels were low, but exhibited significant
Sockeye salmon *Oncorhynchus nerka* spawn in many streams and along lake beaches of the Kvichak River system in Alaska, but fry from the distinct spawning areas reside in a common nursery habitat, Iliamna Lake. In addition, Kvichak River subpopulations have similar dates of adult entry into fresh water, similar migration distances, and similar spawning dates. These similarities in rearing environments and migratory timing enabled us to test the hypothesis that differences in spawning and incubation habitat alone can promote differentiation in traits associated with reproductive success. River-spawning sockeye salmon tended to be larger at age and older than those spawning along island beaches. Females from rivers were more fecund but had smaller eggs than the beach-spawning females. Males from beaches were deeper-bodied and (in one comparison) had relatively longer lower jaws than males from rivers. The tendency of river-spawning females to mature later than beach spawners may be related to a higher marine growth
The effect of an embedded substratum on emigration and growth in juvenile brown trout was investigated in an artificial stream with sand added to produce sections of embedded or nonembedded substratum. Fish were allowed to leave the sections and were caught daily in a downstream trap. After catching and counting, fish were put back in their original section in order to keep the same amount of fish. Captures were high only on the first days after fish release. During the first 6 days after fish release, downstream-moving fish were more numerous in the embedded than in the nonembedded sections. The embedded substratum significantly decreased the final
None
The soils forming on waste rock dump surfaces at the Bingham Canyon Mine have paste pH values ranging from 2.08 to 7.91. Paste conductivity, a measure of soil salinity, varies between 22 and 8750 μS cm^{-1}. The primary controls on waste rock soil pH and salinity are the sulphide distribution in the waste rock, the amount of limestone present and the age of the waste rock dump surface. The average pH of recently exposed waste rock is 7.0 and the average conductivity is 1120 μS cm^{-1}. Within six years of placement on the waste rock dumps the average pH declines to 4.7, further decreasing to 3.7 after 50 years. The average conductivity increases to 3000 μS cm^{-1} within six years but then declines to 855 μS cm^{-1} after 50 years. The sharp drop in pH, and the peak in salinity shortly after the waste rock is placed on the dumps, reflects the rapid release of acidity
A reconnaissance sidescan sonar survey in Bristol Bay, Alaska revealed extensive areas of seafloor with features related to walrus foraging. They are similar to those seen in areas such as the outer Bering Sea and Chukchi Sea. Two types of feature were observed: (a) small (<<1 m diameter) shallow pits, often in clusters ranging in density from 5 pits per hectare to 35 pits per hectare; and, (b) more abundant, narrow, sinuous furrows, typically 5 to 10 m long with some reaching 20 m or more. Most foraging marks were in less than 60 m water depth in areas of sandy seafloor that were smooth, hummocky or characterized by degraded bedforms; the absence of foraging marks in

In December 1991, Cominco Alaska Exploration (the former lease holder of the site now held by the Pebble Limited Partnership) contracted the Alaska Department of Fish Game (ADFG), Division of Wildlife Conservation, to investigate wildlife use and harvest in the proposed Pebble Copper Mine Area, northwest of Iliamna Lake, Alaska. This paper is a compilation of information from: 1) recent moose and bear surveys conducted per the agreement between the ADFG and Cominco Exploration; 2) bear, moose, and furbearers harvest data from 1985/86 - 1990/91; 3) historic aerial survey observations documenting bear use of salmon streams; and, 4) historic trend area counts for moose. Harvest data from the proposed mine area was taken from the Uniform Coding Units (UCU) which include the drainages of Kaskanak Creek (09b-0203), Talarik Creeks (09b-0302), the Chulitna River and Nikabuna Lakes (09b-0701), and the lower Mulchatna River from the confluence with the Koktuli River to the confluence of the Nushagak River (17b-0201) (Figure 1). This report summarizes the results of the investigation. It does not speculate

The US Geological Survey and the National Park Service conducted a water-quality investigation of the Kijik River Basin in Lake Clark National Park and Preserve from June 2004 to March 2005. The Kijik River Basin was studied because it has a productive sockeye salmon run that is important to the larger Kvichak River watershed. Water-quality, physical habitat, and biological characteristics were assessed. Water type throughout the Kijik River Basin is calcium bicarbonate although Little Kijik River above Kijik Lake does have slightly higher concentrations of sulfate and chloride. Alkalinity concentrations are generally less than 28 milligrams per liter, indicating a low buffering capacity of these waters. Lachbuna Lake traps much of the suspended sediment from the glacier streams in the headwaters of the basin as evidenced by low secchi-disc transparency of 1 to 2 meters and low suspended sediment concentrations in the Kijik River downstream from the lake. Kijik Lake is fed by clearwater streams and has secchi-disc readings ranging from 11 to 15 meters. Streambed sediments collected from four surface sites analyzed for trace elements indicated that arsenic concentrations at all sites were above proposed guidelines. However, arsenic concentrations are due to the local geology, not anthropogenic factors. Benthic macroinvertebrate qualitative multi-habitat samples collected from two sites on the Little Kijik River and two sites on the main stem of the Kijik River indicated a total of 69 taxa present among the four sites. The class Insecta, made up the largest percentage of macroinvertebrates, totaling 70 percent of the families found. The insects were comprised of four orders; Diptera (flies and midges), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera

None

Cominco Alaska Exploration is pursuing a mineral exploration project, the Pebble Copper Prospect, in the area of the headwaters of the Koktuli River and Upper Talarik Creek, north of Lake Iliamna. The prospect site is on the divide separating the Upper Talarik Creek and South Fork Koktuli River watersheds, and very near the divide between these two watersheds and the upper North Fork Koktuli River watershed. Reconnaissance level investigations were undertaken in August of this year to gain an understandng of the distribution and relative abundance of fish species in the area and of the factors which may be limiting that distribution and relative abundance. Information was gathered on fish occurrence within the upper basins of the north and south forks of the Koktuli River, Upper Talarik Creek, and the small basins tributary to the Chulitna River and on factors influencing distribution and relative abundance. Potential impacts of prospect development will be addressed in later phases of investigations. The purposes of this Technical Memorandum is to summarize the results of these preliminary investigations.

An intensive research program was conducted in 1961 and 1962 by the Bureau of Commercial Fisheries Biological Laboratory, Auke Bay, Alaska, and the Fisheries Research Institute, University of Washington, with the cooperation of the Alaska Department of Fish and Game. Many sockeye salmon river systems were studied concurrently with essentially the same techniques so that systems covering the entire range of production levels could be compared. The general objective of this research was to determine the optimum escapement of sockeye salmon for each of the major systems. This was accomplished through integration of the results of several related studies: (1) summarization and analysis of historical and current data on runs of adult sockeye salmon, (2) delineation and description of spawning areas and estimation of their capacities, (3) delineation and description of the nursery areas and estimation of their capacities. The major systems studied were the Wood, Kvichak, Naknek, and Ugashik systems, which enter Bristol Bay; the Chignik system, on the south side of the Alaska Peninsula; and the Karluk system, on Kodiak Island. Adult sockeye salmon in the commercial catches and escapements, and sockeye salmon smolts, were counted and sampled. Spawning grounds were surveyed to determine their size and quality and the distribution and abundance of spawners. Bathymetric maps were prepared for some of the nursery lakes. Intensive limnological studies, including a major effort to measure

Over the past decade, accelerating rates of species extinction have prompted an increasing number of studies to reduce species diversity experimentally and examine how this alters the efficiency by which communities capture resources and convert those into biomass. So far, the generality of patterns and processes observed in individual studies have been the subjects of considerable debate. Here we present a formal meta-analysis of studies that have experimentally manipulated species diversity to examine how it affects the functioning of numerous trophic groups in multiple types of ecosystem. We show that the average effect of decreasing species richness is to decrease the abundance or biomass of the focal trophic group, leading to less complete depletion of resources used by that group. At the same time, analyses reveal that the standing stock of, and resource depletion by, the most species-rich polyculture tends to be no different from that of the single most productive species used in an experiment. Of the known mechanisms that might explain these trends, results are most consistent with what is called the 'sampling effect', which occurs when diverse communities are more likely to contain and become dominated by the most productive species. Whether this mechanism is widespread in natural communities is currently controversial. Patterns we report are remarkably consistent for four different trophic groups (producers, herbivores, detritivores and predators) and two major ecosystem types (aquatic and terrestrial)

Pacific salmon and other anadromous salmonids represent a major vector for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Salmon carcasses provide nutrients and energy to biota within aquatic and terrestrial ecosystems through various pathways. In this paper we review and synthesize the growing number of studies documenting this process in different localities. We also discuss the implications for maintaining the nutrient feedback system. Our findings show that future management will need to view spawning salmon

The proposed Pebble Project, by Northern Dynasty Mines, Inc. (NDM) and Anglo American plc, is a low grade copper-gold-molybdenum sulfide deposit in SW Alaska. The deposit outcrops on the surface (Pebble West, PW), requiring open pit mining methods, and extends under non-ore bearing rocks (Pebble East, PE), requiring underground block caving. The deposit sits on a drainage divide, with the Upper Talarik (UT) River draining east and south, and the North Fork (NFK) and South Fork (SFK) Koktuli rivers draining west and southwest, respectively. Mining of the ore deposit would result in an open pit and underground mine at the headwaters of the SFK and UT watersheds. The mine waste (tailings and waste rock) would be stored in two Tailings Storage Facilities located in the SFK and NFK watersheds. The PW open pit is projected to have a pit lake. Pit water can be impacted by the rock remaining in the pit walls, especially that material exposed by fracturing and rubbilization due to mining. If the water in the pit is of poor quality from decomposition of sulfide minerals, and the hydrology facilitates flow down gradient to ground and surface waters, there could be long term impacts to water off the minesite. Subsidence will likely occur due to block caving at PE. Subsidence at the surface allows water to enter the underground mine from above and contact broken rock that will remain underground. The rock in the remaining underground workings in the deposit will be mineralized. This could lead to decomposition of sulfide minerals and acid mine drainage. If a flow path exists from the mine workings to ground and surface waters down gradient from the mine, migration of contamination off the mine site would be a long term issue. Tailings dams will be built to contain waste, several with heights over 700 feet. Tailings dams must stand in perpituity. A large earthquake might cause failure of a tailings dam. A catastrophic release of a large amount of tailings could lead to long term environmental damage with huge cleanup costs. The probability of such failure is low, but the consequences are very high. A 104-mile industrial road will connect the mine and the port sites, with a concentrate pipeline parallel to the road. The pipeline will be engineered with leak detection systems and shutoff valves, though material between the shutoff valve and a break can still leak from a ruptured pipeline. Concentrates are moved via conveyor onto a ship for transport to a smelter. Concentrate spills during ship
Mean length, mean weight, percentage by age class, sample size, and standard error term statistics are presented by gear type for samples of Arctic grayling *Thymallus arcticus* collected over a 26-year period (1964 through 1989) from waters of Southwest Alaska. Of the 10,298 records summarized in tabular form, age estimates, based on scale samples, are available for approximately 7,043 records. This document is the most complete and uniform summary of available size and age information yet to be
An angler effort survey was conducted on the Alagnak River from 10 June - 10 August, 2000. This was a collaborative effort between the Alaska Department of Fish and Game - Division of Sport Fish (ADFG), the National Park Service (NPS), and the Bristol Bay Native Association (BBNA). ADFG provided detailed data collection instructions and technical review of the project design. Several problems were encountered during the project and it was not completed as scheduled. However, the data collected indicated that during the study year there was heavier use of the lower river than the upper river and peak use occurred during July. Rafts were most common in the upper river and decreased in frequency with each downstream segment. Overall use was dominated by

This report details the inventory of mammals in Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003 as part of a cooperative effort of the Beringian Coevolution Project at the Museum of Southwestern Biology, University of New Mexico and the Inventory and Monitoring Program of the National Park Service of Alaska. We begin the process of documenting the approximately 36 species of mammals that occur in the Park, with a primary focus on small mammals (i.e., shrews, voles, lemmings, weasels, porcupine, squirrels, and hares). This survey resulted in 856 primary specimens comprising 17 species. Across all localities sampled, two shrews (*Sorex cinereus, S. monticolus*) and a murid rodent (*Clethrionomys rutilus*) were the most frequently captured species, comprising over 85% of all mammals sampled. The discovery of singing vole (*Microtus miurus*) at Turquoise Lake constitutes a new mammal for the park and a major range extension for the species. This inventory also provided the first documented records in LACL of pygmy shrew (Sorex hoyi), montane shrew (*Sorex monticolus*), tundra shrew (*Sorex tundrensis*), little brown bat (*Myotis lucifugus*), and ermine (*Mustela erminea*). Two tiny shrews (*Sorex yukonicus*) collected at Turner Bay are only the second record of this rare species in the park and constitutes the latest additions to the 37 specimens now known to science. The findings from this study, when combined with specimen information gathered from a review of holdings at the University of Alaska Museum and other major collections, bring the total number of documented small mammal species in LACL to 18 of 22 probable species, or 82% coverage. The

Juvenile coho salmon (*Oncorhynchus kisutch*) production (tissue elaboration) was monitored in 12 laboratory streams under six replicate treatment levels of fine sedimentation. Increasing sedimentation supressed fish production. Our data confirm that habitats of salmonid juveniles, as well as spawning areas, should be protected against fine sediments. Substrate Score, a visual technique for evaluating stream substrate quality, correlated closely with both the geometric mean particle size of the

None

Between 1991 and 1993, Alaska harbor porpoise (*Phocoena phocoena*) abundance was investigated during aerial surveys throughout much of the coastal and offshore waters from Bristol Bay in the eastern Bering Sea to Dixon Entrance in Southeast Alaska. Line-transect methodology was used, and only those observations made during optimal conditions were analyzed. Survey data indicated densities of 4.48 groups/100 km^2, or approximately 3,531 harbor porpoises (95% C.I. 2,206-5,651) in Bristol Bay and 0.54 groups/100 km^2, or 136 harbor porpoises (95% C.I. 11-1,645) for Cook Inlet. Efforts off Kodiak Island resulted in densities of 1.85 groups/l00 km^2, or an abundance estimate of 740 (95% C.I. 259-2,115). Surveys off the south side of the Alaska Peninsula found densities of 2.03 groups/100 km^2 and an abundance estimate of 551 (95% C.I. 423-719). Surveys of offshore waters from Prince William Sound to Dixon Entrance yielded densities of 4.02 groups/100 km^2 and an abundance estimate of 3,982 (95% C.I. 2,567-6,177). Combining all years and areas yielded an uncorrected density estimate of 3.82 porpoises per 100 km^2, resulting in an abundance estimate of 8,940 porpoises (CV =

1. The uptake of heavy metals via the alimentary tract can be an important factor for the metal budget of fish. 2. Concepts such as biomagnification, bioaccumulation, biotransference, or concentration factors, convey little information about the real threat originating from heavy metals in an aquatic food chain. 3. In polluted aquatic ecosystems the transfer of metals through food chains can be high enough to bring about harmful concentrations in the tissues of fish. This relationship is called the food chain effect. 4. Two kinds of ecological factors influence the food chain effect: firstly, high levels of contamination of the food, and, secondly, the reduction of species diversity. When susceptible species are eliminated, metal-tolerant food organisms may become dominant. Their tolerance may be based either on their ability to accumulate excessive amounts of metals or to exclude heavy metals from the tissues. These two strategies represent feedback mechanisms which may enhance or weaken the food chain effect. 5.

Bristol Bay Management Area supports the largest sockeye salmon *Oncorhynchus nerka* fishery in the world. A key to the sustainability of the fishery has been conservation of sockeye salmon biodiversity, which is derived from a wide variety of life history types and multiple distinct, locally adapted populations. Alaska Department of Fish and Game is responsible for managing commercial fisheries in Bristol Bay under the sustained yield principal. Accurately estimating the stock composition of catch within the fishing districts is critical to determining the total run (catch and escapement) of each stock, especially considering that sockeye salmon stocks in Bristol Bay can be exploited at rates up to 80%. In recent years, the department has developed a genetics program for sockeye salmon in Bristol Bay to develop and apply genetic methods to identify the stock composition of mixtures (mixed stock analysis; MSA). Here we investigate where fish from different stocks are captured in the commercial fishing districts during 2006, 2007, and 2008 and compare these results to those based on the traditionally used method of age-based MSA. Results from genetic data support results from previous studies showing that high proportions of the stocks captured in fishing districts were under- or over estimated by large amounts (2%-435%), and that these new estimates resulted in considerably different estimates of total run by stock (1%-164%) compared to traditional methods. The magnitude of these differences varied among years, highlighting the

Molting adult Stellar's Eiders (*Polysticta stellari*) were banded at Izembek Lagoon (1961-1998) and Nelson Lagoon (1995-1997) along the lower Alaska Peninsula to determine breeding distribution and movements. Of 52,985 Stellar's Eiders banded, 347 were recovered. The overall low recovery rate may not be indicative of harvest levels but may be due to low reporting rates of bands. Almost all recoveries during summer were from Russia and recovery rates did not vary between sexes. We found no evidence that Stellar's Eiders molting in specific locations were more likely to be recovered in specific geographic locations in Russia. Our recoveries suggest that Stellar's Eiders molting

The 29th consecutive spring aerial emperor goose survey was conducted from 1-3 May. The survey area is coastline and estuarine habitats from Jacksmith Bay to Wide Bay, including the north and south sides of the Alaska Peninsula. A total of 91,948 emperor geese were observed, up 41.6% from 2008 and up 43.2% from the long-term average (64,190, 1981-2008). This is the second largest count since the survey began bringing the recent 3-year average management index to 78,144 birds (up 7.2% from the previous 3-yr average of 72,864). Other species of emphasis included Pacific brant and

Are tailings impoundments the most challenging facilities that geotechnical engineers will encounter during their careers? Whether one answers yes or no, there can be no argument that these facilities are indeed challenging and that there is little room for error in their design and stewardship. Where more room has been sought, failures have been the all too frequent result. Can these failures be avoided? Many geotechnical practitioners get involved with mine tailings impoundments. These practitioners should make themselves familiar with the extensive and, unfortunately, growing database of mine tailings impoundment failure case histories. Many of the failures in the database have been the direct result of a geotechnical failure mode; failure modes that should be

Mining of massive sulfide deposits in southwestern Spain extending back to the Copper and Bronze Ages has resulted in the pollution of the Rio Tinto fluvial-estuarine complex, the site of Columbus' departure for the New World in 1492. Additional sources of potential pollution include the large industrial complex at Huelva near the lower portion of the estuary. Extensive analysis of surface sediment samples and cores has established that there are no geographic trends in the distribution of the pollutants, which include Cu, Fe, Pb, Zn, Ti, Ba, Cr, V and Co. These data have, however, demonstrated that tidal flux within the estuary carries phosphorus and perhaps other elements from the industrial complex at Huelva to the tidal limit of the system, several kilometers upstream from the discharge site. Radiometric analysis of short cores shows that sedimentation rates over

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Information about the red salmon runs and the spawning streams and beaches in the Kvichak River System, Bristol Bay, Alaska, is cataloged in this volume. The material is compiled from data obtained from spawning ground surveys made in the area since 1955 by the Fisheries Research Institute of the University of Washington. Earlier work was financed by the salmon canners of Bristol Bay. In recent years the work was supported by the Bureau of Commercial Fisheries. For each spawning stream or beach, the catalog gives, whenever available, the stream catalog number, name, location, and physical description, including dimensions, bottom quality, flow barriers, watershed size and type, vegetation, gradient, water velocity, estimated flow, air and water temperature, and general information including shelter, survey routes and methods, personal-use fisheries, and wildlife species. Then a description of red salmon runs to the area is listed, including magnitude of the run and timing and distribution of spawning. Estimates

A large and growing body of literature has documented the transfer of marine-derived nutrients from the ocean to freshwater and riparian systems by semelparous Pacific salmon *Oncorhynchus* spp. The pathways by which these nutrients reach resident fish are often indirect, and the evidence for direct benefits to the resident fish is not always conclusive. However, the consumption of salmon tissue (in one form or another) by resident fish would constitute a direct and efficient pathway for energy transfer. We studied a population of small-bodied, nonanadromous Dolly Varden *Salvelinus malma* feeding on the fry and eggs of sockeye salmon *O. nerka* and blowfly (family Calliphoridae) larvae that had fed on salmon carcasses at a series of spring-fed and otherwise unproductive ponds in southwestern Alaska. The Dolly Varden fed heavily on sockeye salmon fry when available, shifted their diet almost exclusively to eggs after salmon spawning commenced, and then shifted to blowfly larvae toward the end of the season. Dolly Varden large enough to eat eggs moved into ponds where sockeye salmon spawn synchronously with the arrival of the salmon, and Dolly Varden growth rates increased greatly once salmon eggs and blowfly maggots were available. Young-of-the-year Dolly Varden, which were too small to eat eggs and fry, were concentrated in small streams between ponds where fewer sockeye salmon spawn, perhaps to minimize the risk of predation from larger conspecifics. These results indicate the importance of a

The impact of mining and smelting of metal ores on environmental quality is described. Mines produce large amounts of waste because the ore is only a small fraction of the total volume of the mined material. In the metal industry, production of Cu, Pb, and Zn causes the greatest degradation of the environment. Copper mining produces extensive mine wastes and tailings and Cu smelting emits approximately 0.11 Mg of S per Mg of Cu produced in the USA. Zinc and Pb smelters release large quantities of Cd and Pb into the environment. Metal smelting and refining produce gaseous (CO_2, SO_2, NO_x, etc.) and particulate matter emissions, sewage waters, and solid wastes. Soil contamination with trace metals is considered a serious problem related to smelting; however, mining and smelting are not main sources of global metal input into soils. Other sources like discarded manufactured products, coal ash, agriculture, and transportation take a lead. Smelters are the main sources of atmospheric emissions of As, Cu, Cd, Sb, and Zn on a global scale and they contribute substantially to the overall emissions of Cr, Pb, Se, and Ni. A quantitative evaluation of the environmental health effects of mining and smelting is difficult because of the complexity of factors involved and lack of consistent methodology. Nevertheless, the case studies described indicate

This paper provides an estimate of the economic value of wild salmon ecosystems in the major watershed of Bristol Bay, Alaska. The analysis utilizes both regional economic and social benefit-cost accounting frameworks. Key sectors analyzed include subsistence, commercial fishing, sport fishing, hunting, and nonconsumptive wildlife viewing and tourism. The mixed cash-subsistence economy of Bristol Bay supports a population of 7,611 (2000 census) that is 67 percent Alaska Native. Estimated expenditures and net economic values for all sectors were based on a literature review and available data, with the exception that original data was collected for 2005 on the sport fish sector using a random sample of licensed Alaska anglers. Methods included use of a regional input-output model maintained at the University of Alaska, and survey research and contingent valuation methods for the sport fishermen. Potential respondents included 886 resident anglers and 1,514 nonresident anglers contacted through a mail/internet approach. Additionally, 300 licensed anglers, 330 clients of Bristol Bay fishing lodges, and 46 lodge owners were contacted through a mail survey. Response rates ranged from 25.6 percent for resident anglers to 44.1 percent for nonresidents. Estimated direct expenditures/sales were $234.4 million in 2005 for commercial fishing and processing, $61 million for sport fishing, $17.1 million for wildlife viewing, $7.2 million for subsistence-related expenditures, and $12.4 million for sport hunting. Nearly 100 percent of the private basic

None

This report summarizes sport fisheries addressed in Bristol Bay proposals to the Alaska Board of Fisheries during 2009. Fisheries include Nushagak-Mulchatna Chinook salmon (king) *Oncorhynchus tshawytscha*, and Brooks River and American Creek rainbow trout *O. mykiss*. The sport fisheries are described, and estimates of sport effort, catch, and harvest, and escapement are provided. Overviews of management for each fishery are provided, such as pertinent sport fishing regulations and management plans, including

The effects of climate warming on the thermal habitat of 57 species of fish of the U.S. were estimated using results for a doubling of atmospheric carbon dioxide that were predicted by the Canadian Climate Center general circulation model. Baseline water temperature conditions were calculated from data collected at 1,700 U.S. Geological Survey stream monitoring stations across the U.S. Water temperatures after predicted climate change were obtained by multiplying air temperature changes by 0.9, a factor based on several field studies, and adding them to baseline water temperatures at stations in corresponding grid cells. Results indicated that habitat for cold and cool water fish would be reduced by -5O%, and that this effect would be distributed throughout the existing range of these species. Habitat losses were greater among species with smaller initial distributions and in geographic regions with the greatest warming (e.g. the central Midwest). Results for warm water fish habitat were less certain because of the poor state of knowledge regarding their high and low temperature tolerances; however, the habitat

Ecological risk assessment (ERA) has become an essential tool for determining impacts to biological receptors as a result of contamination from metal mining facilities (Brumbaugh et al. 1994, Canfield et al. 1994, Ingersoll et al. 1994, Kemble et al. 1994, Pascoe and DalSoglio 1994, Pascoe et al. 1994, Linkov et al. 2002). The United States Environmental Protection Agency (EPA) Risk Assessment Forum developed the Framework for Metals Risk Assessment (2007a), which is a science-based document that addresses the special attributes and behaviors of metals and metal compounds to be considered when assessing their human health and ecological risks. To date, efforts have been designed to address the impacts or risks posed by metals contamination subsequent to mining operations. Few, if any, ERAs have been directed at pre-mining impacts. Smith (2007) provided strategies to predict metal mobility at mining sites through evaluation of source characterization, geoenvironmental models, geoavailability, and metals speciation; controlling physicochemical attributes (e.g., solubility, pH, sorption) in aqueous environments are discussed relative to their potential to alter metals bioavailability. The relevance of historical information on metals contamination associated with other mine sites, along with the potential for acid mine drainage (AMD) and metals release and exposure, based on review of the baseline data and geochemical characteristics at a site, have been used to develop both quantitative and qualitative predictions of risk. The present ERA is designed to analyze and portray the potential risks to globally significant salmon resources of the Nushagak-Mulchatna, and Kvichak river drainages (proximal headwater areas) as a result of large-scale mining and associated facilities. These risks include both physical destruction and alteration of salmon habitat, in addition to probable effects from changes to water chemistry and

The study examined two competing hypotheses seeking to explain the Kvichak cycle: (1) existence of a depensatory agent independent of the fishery and (2) depensatory fishing. The first hypothesis was implicit in the status quo harvest policy. Available data were analyzed to evaluate the alternative hypotheses. Little evidence for direct depensatory mortality independent of the fishery was found, however, production was depressed in brood years following large escapement brood years. In addition, the fishery itself was found to be extremely depensatory. A stochastic empirical computer simulation model incorporating processes found in the data analyses was used to examine the consistency of brood year interaction with the depensatory fishing hypothesis and historical cyclic patterns in the Kvichak run. The model predicted weak cyclic patterns in the unexploited run and strong cyclic patterns, consistent with the historical patern, in the run exploited under the status quo harvest policy of cyclic escapement goals. The model was then used to evaluate the alternative harvest policies. There were almost no differences in simulated catches under the status quo and static fixed escapement goal and static rate of exploitation policies. Substantial increases in simulated catch occurred with a dynamic policy of alternate years of high

We studied the migration and winter distribution of adult Greater Whitefronted Geese (Anser alibfrons frontalis) radio-marked on the Yukon Kuskokwim Delta (YKD) and Bristol Bay Lowlands (BBL) of Alaska from 1987 to 1992. The major autumn staging site for geese from both breeding areas was the Klamath Basin on the California/Oregon border. However, temporal use of this area differed markedly between populations. Geese from the BBL arrived at the Klamath Basin nearly 30 days before geese from the YKD and departed before most YKD geese had arrived. Ninety percent of BBL geese used the Klamath Basin in autumn, whereas 30% of YKD geese bypassed the Klamath Basin during autumn and instead flew directly to the Central Valley of California. Nearly all BBL geese migrated directly from the Klamath Basin to wintering areas in Mexico, bypassing the Central Valley. Ninety percent of the BBL geese wintered in Mexico, as opposed to $<20\%$ of the YKD geese. Wetlands of the Interior Highlands in the state of Chihuahua, particularly Laguna Babicora, were used by $>90\%$ of the radio-marked geese in Mexico. Marshes along the West Coast comprised the other important wintering habitat in Mexico. The Sacramento Valley of California was the predominant wintering area for YKD geese. BBL geese migrated north from Mexico into the San Joaquin Valley or Sacramento-San Joaquin Delta of California by the last week of January. Fifty-five percent of the BBL population used the Klamath Basin in spring, but many birds staged in eastern Oregon and western Idaho. In contrast, geese from the YKD staged almost exclusively in the Klamath Basin during spring before flying to staging areas in Alaska. Breeding allopatry and temporal partitioning on staging and wintering areas likely has
A marked vertical trend of increasing temperature and dissolved metal concentrations is observed in the monimolimnia of some meromictic pit lakes of the Iberian Pyrite Belt (IPS) in SW Spain. Temperature differences between the chemocline and the pit lake bottom can be as high as 15°C (e.g. Herrerias), and the respective concentration of some metals (e.g., Fe) and metalloids (e.g., As) can increase by several orders of magnitude (e.g., Cueva de la Mora). The redox conditions also change drastically from the upper and oxygenated mixolimnion (strongly oxidizing) to the lower and anoxic monimolimnion (moderately reducing). Processes such as the inflow of metal sulphate laden ground water from flooded shafts and galleries, and other factors such as the pit geometry or the relative depth of the lakes, must be considered to account for the observed stratification pattern. The vertical profiles of physico-chemical parameters and water chemistry obtained in Cueva de la Mora and other meromictic pit lakes of the IPB
Between June 1975 and June 1977, five aerial surveys were conducted along the eastern Aleutian Islands and throughout Bristol Bay to study the distribution and abundance of the harbor seal (*Phoca vitulina richardsi*) during the breeding season. The number of group sightings and the total number of seals observed varied significantly with the tide height ($P<0.01$). Fifty-seven percent more seals were observed on a low tide than in the same area surveyed near high tide. Three locations-Port Moller, Port Heiden, and Cinder River along the north side of the Alaska Peninsula accounted for 78
We constructed a patch dynamics model which can be used to simulate the changing sizes of resident populations in a series of interconnected habitat patches. We applied the model to white-footed mice (*Peromyscus leucopus*) inhabiting patches of forest in an agricultural landscape. The model predicts that mouse populations in isolated woodlots have lower growth rates and are thus more prone to extinction than those in connected

The Kvichak River of Bristol Bay, Alaska, is one of the world's largest sockeye salmon producing systems. This paper reviews and documents past management practices for the Kvichak River sockeye salmon. Fishery harvests are managed to meet a biological spawning escapement goal set by the State of Alaska and regulated using management plans adopted by the Alaska Board of Fisheries. Several measures of inseason run abundance are used to determine time and area of fishery openings that allow the escapement goal to be met and ensure that escapement is obtained throughout the run. Returns to the Kvichak River have been relatively small for seven of the past eight years. To hasten rebuilding of this run, the Alaska Board of Fisheries implemented additional management plans in 2001 that limit incidental harvests of Kvichak River sockeye salmon. These restrictions were effective in decreasing the catch of Kvichak River sockeye salmon, but total escapements achieved in 2002 and 2003 were still below the lower end of the escapement goals thought to produce the greatest catches in the future. While small runs and resulting low escapement levels have restricted commercial and sport fishery harvests, sustainability of this sockeye salmon run does not appear threatened at this time. The escapement goal for the Kvichak River is set at a level that provides the greatest potential for obtaining maximum sustained yield. While it is unlikely

Since 1980, the Division of Subsistence of the Alaska Department of Fish and Game has conducted research on contemporary hunting, fishing, and gathering in Alaska Native and other rural Alaska communities. This paper describes the division's research program and some the results of the division's studies. First, there is an overview of the state and federal legislation which provides a preference for subsistence uses in resource management and allocation decisions. Next, the division's research methods are discussed, followed by a summary of some of the recent findings about the role of subsistence uses in the mixed subsistence-based economies of Alaskan villages. A description of a "baseline" study in the Central Yup'ik Eskimo village of Manokotak illustrates the kinds of information which the division has collected for about 151 communities. The paper also illustrates how these data have been applied in resource management decisions. In conclusion, the paper speculates about the future of the

This report presents updated information about subsistence uses of fish, wildlife, and plant resources in 5 communities of southcentral Alaska -- Iliamna, Newhalen, Nondalton, Pedro Bay, and Port Alsworth. The Division of Subsistence of the Alaska Department of Fish and Game conducted the study in collaboration with the National Park Service and Stephen R. Braund & Associates. The Pebble Project is a proposed open pit mine located 18 miles to the northwest of Iliamna and 18 miles southwest of Nondalton. The potential development of the mine requires updated baseline information about subsistence harvests and uses. Information was collected through systematic household surveys and mapping interviews. Scoping meetings were held in each community to elicit ideas about research questions and to learn more about issues. After preliminary study findings were available, a second round of community meetings took place to review the results. In total, 116 households were interviewed, 79% of the year-round resident households. The study documented the continuing importance of subsistence hunting, fishing, and gathering to the study communities. In 2004, virtually every person in each community participated in subsistence activities and used wild resources. Subsistence harvests were large and diverse. Estimated wild resource harvests were 469 pounds usable weight per person in Iliamna, 692 pounds per person in Newhalen, 358 pounds per person in Nondalton, 306 pounds per person in Pedro Bay, and 133 pounds per person in Port Alsworth. Most participants in this study reported their subsistence uses and harvests have changed in their lifetimes and over the last 5

None
Each year thousands of Alaskans participate in subsistence activities including the harvest of wild resources from Alaska's fisheries. Subsistence fishing is an important element of Alaska's social and cultural heritage, as well as a crucial component of the subsistence sector of the state's economy. This report summarizes Alaska's 2007 subsistence fishing season based upon subsistence permit data and harvest assessment surveys from across the state. New information is compared to findings from previous years and the results are discussed. Where appropriate, harvest
This final report presents the results of an ethnographic project that investigated how families in 4 communities of the Kvichak District of the Bristol Bay Management Area of Southwest Alaska develop subsistence fishing strategies, such as when to fish, where to fish, who to fish with, and how much to harvest, in response to changing sociocultural, economic, and environmental circumstances. Research methods included participant observation at fish camps, key respondent interviews, family case studies, and systematic household surveys. This report describes case examples of summer subsistence fishing for sockeye salmon *Oncorhynchus nerka*, examples of subsistence fishing in the fall for spawning sockeye salmon, and a review of the use of seine nets as a subsistence sockeye salmon fishing method at Nondalton. The report concludes that the subsistence fishery is vital to the way of life of the study communities, and is accomplished in an efficient and sustainable manner informed by traditional knowledge. Annual and long term variations in the fishery are shaped by a complex set of environmental, economic, cultural, and personal factors. Also, findings based on household surveys and permit returns suggest that relying solely on permit returns results in an underestimate of subsistence sockeye salmon harvests. Additional outreach
Abandoned tailings and mine adits are located throughout the Boulder River watershed in Montana. In this watershed, all species of fish are absent from some tributary reaches near mine sources; however, populations of brook trout *Salvelinus fontitalis*, rainbow trout *Oncorhynchus mykiss*, and cut-throat trout *O. clarki* are found further downstream. Multiple methods must be used to investigate the effects of metals released by past mining activity because the effects on aquatic life may range in severity, depending on the proximity of mine sources. Therefore, we used three types of effects -- those on fish population levels (as measured by survival), those on biomass and density, and those at the level of the individual (as measured by increases in metallothionein, products of lipid peroxidation, and increases in concentrations of tissue metals) -- to assess the aquatic health of the Boulder River watershed. Elevated concentrations of Cd, Cu, and Zn in the water column were associated with increased mortality of trout at sites located near mine waste sources. The hypertrophy (swelling), degeneration (dying), and necrosis of epithelial cells observed in the gills support our conclusion that the cause of death was related to metals in the water column. At a site further downstream (lower Cataract

In the summer of 2007, the U.S. Geological Survey (USGS) began an exploration geochemical research study over the Pebble porphyry copper-gold-molydenum (Cu-Au-Mo) deposit in southwest Alaska. The Pebble deposit is extremely large and is almost entirely concealed by tundra, glacial deposits, and post-Cretaceous volcanic and volcaniclastic rocks. The deposit is presently being explored by Northern Dynasty Minerals, Ltd., and Anglo-American LLC. The USGS undertakes unbiased, broad-scale mineral resource assessments of government lands to provide Congress and citizens with information on national mineral endowment. Research on known deposits is also done to refine and better constrain methods and deposit models for the mineral resource assessments. The Pebble deposit was chosen for this study because it is concealed by surficial cover rocks, it is relatively undisturbed (except for exploration company drill holes), it is a large mineral system, and it is fairly well constrained at depth by the drill hole geology and geochemistry. The goals of the USGS study are (1) to determine whether the concealed deposit can be detected with surface samples, (2) to better understand the processes of metal migration from the deposit to the surface, and (3) to test and develop methods for assessing mineral resources in similar concealed terrains. This report presents analytical results for geochemical samples collected in 2007 from the Pebble deposit and surrounding environs. The analytical data are presented digitally both as an integrated Microsoft 2003 Access ® database and as Microsoft 2003 ® Excel files. The Pebble deposit is located in southwestern Alaska on state lands about 30 km (18 mi) northwest of the village of Illiamna and 320 km (200 mi) southwest of Anchorage (fig. 1). Elevations in the Pebble area range from 287 m (940 ft) at Frying Pan Lake just

The present report presents analytical results for geochemical samples collected in 2008 from the Pebble deposit and surrounding areas. The analytical data are presented digitally both as an integrated Microsoft 2003 Access® database and as Microsoft 2003 Excel® files. During two 2008 sampling periods, July 07-20 and September 20-24, USGS scientists collected soil, water, bedload stream sediment, bedload pond sediment, pond-sediment core, heavy-mineral concentrate, and till samples from the deposit area with the aid of helicopter support because the site currently lacks transportation infrastructure that allows ease of access. The sampling was undertaken during relatively dry and stable weather conditions. Only minor scattered rain showers occurred during the sampling periods, so surface conditions were largely unaffected by weather. The

None

None

Because of the burgeoning interest in salmon, growing indications of their ecological importance, and recent calls for management to consider the role of salmon in aquatic and terrestrial ecosystems (e.g., Larkin and Slaney 1997), we take this opportunity to review what is understood about the function of salmon as key elements of ecological systems. Our objectives are twofold. First, we expand on previous reviews of salmon (Willson et al. 1998, Cederholm et al. 1999) to include recent research that has amplified and modified earlier ideas about the contribution of salmon to ecosystem processes. In doing so, we describe the composition, magnitude, and distribution of marine inputs to freshwater and terrestrial systems via salmon. We use an expanding group of studies pertaining to stream nutrient budgets and salmon physiology to construct a schematic that illustrates salmon-derived products and the pathways by which they enter and are retained in aquatic and terrestrial food webs. We then consider the ecological variation associated with salmonid ecosystems and how this may influence the ecological response to the salmon input. Second, we consider how this variation in ecosystem response may influence management and conservation efforts. We conclude by suggesting new research directions to help fill the gaps in our current understanding of salmonid ecosystems.

There are three breeding populations of the Marbled Godwit *Limosa fedoa* (Linnaeus): the prairie-breeding birds of mid-continent North America, and widely separated tundra-breeding populations at James Bay, Canada, and in the vicinity of Ugashik Bay, Alaska, on the north coast of the Alaska Peninsula. The Alaska population, which apparently winters locally on the Pacific coast from Washington to northern California, comprises birds with shorter tarsi, shorter wings, shorter culmens, and more massive bodies than those of the mid-continent population. Believed to have persisted near Ugashik Bay

None

Understanding changes in spatial and temporal patterns of harvest is vital for proper management of wolverine *Gulo gulo* populations. In Alaska, wolverines occupy nearly all areas of the state and are classified as furbearers and big game, with annual harvests averaging 545 (SD = 80) individuals since 1984. Because wolverine reproductive potential and survivorship are relatively low, it is important to understand spatial and temporal harvest dynamics to ensure populations are not overharvested. We analyzed the effects of geographic region, time period and number of harvesters on wolverine harvest using Poisson regression modeling. We also examined local harvest patterns for a portion of south-central Alaska where human population levels and concentrations of roadways differ substantially. Patterns of wolverine harvest during 1984-2003 indicated consistently higher harvest densities (wolverines/1,000 sq.-km) in the southern portion of Alaska. The Poisson regression model (goodness of fit: Chi-square = 1300, df = 1288, P = 0.60) estimated mean annual harvest levels (wolverines/1,000 sq.-km) that were higher in South-central (0.35) than in Arctic/West (0.11; P = 0.009) and Interior (0.19; P = 0.001), but no other regional comparisons were significant. Geographic region, time period and number of harvesters were all significant covariates for describing wolverine harvest (P < 0.001 for each). Wolverine harvest densities at the local level indicated that areas with higher harvest densities were well distributed, but that areas with light or no

Spawning migration of adult male chinook salmon *Oncorhynchus tshawytscha* was monitored by radio telemetry to determine their response to the presence of metals contamination in the South Fork of the Coeur d'Alene River, Idaho. The North Fork of the Coeur d'Alene River is relatively free of metals contamination and was used as a control. In all, 45 chinook salmon were transported from their natal stream, Wolf Lodge Creek, tagged with radio transmitters, and released in the Coeur d'Alene River 2 km downstream of the confluence of the South Fork and the North Fork of the Coeur d'Alene River. Fixed telemetry receivers were used to monitor the upstream movement of the tagged chinook salmon through the confluence area for 3 weeks after release. During this period, general water quality and metals concentrations were monitored in the study area. Of the 23 chinook salmon observed to move upstream from the release site and through the confluence area, the majority (16 fish, 70%) moved up the North Fork, and only 7 fish (30%) moved up the South Fork, where greater metals concentrations were

Pacific salmon *Oncorhynchus* spp. play a central role in coastal ecosystems that rim the North Pacific Ocean. Given the ecological, cultural, and economic importance of Pacific salmon, there is great interest in defining the magnitude and frequency of change in these fish stocks. Fisheries scientists, through analyzing harvest records, have demonstrated pronounced salmon production variability. The causes underlying such marked fluctuations are currently debated. Collating harvest records across a broad geographic range over the past ~80 years, fisheries scientists have advanced a plausible argument that climate-induced oceanographic changes explain a significant fraction of the variation in salmon catch records. However, without data that predate the introduction of large-scale human interventions (e.g., commercial harvesting, dams, hatchery releases), it is difficult to isolate the role of climate in shaping fish stock dynamics. Within the past decade, however, we have developed a paleolimnological approach for tracking past sockeye salmon *Oncorhynchus nerka* population abundances, and numerous papers have applied this approach to infer changes in these fish over the past hundreds to thousands of years. Here, we provide an overview of the approach and a synthesis of the work that has been conducted in this field to date. It is clear that numerous sockeye salmon populations have undergone pronounced changes, even prior to human interventions. Furthermore, tracking salmon populations over

We used historical cannery records and current escapement and harvest records to estimate historical and current salmon escapement to western North American river systems, in order to determine the biomass and marine-derived nitrogen and phosphorous levels delivered by adult salmon, and the deficits corresponding to the diminished returns of adult salmon over the past century. We have estimated the historic biomass of salmon returning to the Pacific Northwest (Washington, Oregon, Idaho, and California) to be 160-226 million kg. The number of fish now returning to these rivers has a biomass of 11.8-13.7 million kg. These numbers indicate that just 6-7% of the marine-derived nitrogen and phosphorous once delivered to the rivers of the Pacific Northwest is currently reaching those streams. This nutrient deficit may be one indication of

Pacific salmon are an important biological and economic resource of countries of the North Pacific rim. They are also a unique group of fish possessing unusually complex life histories. There are seven species of Pacific salmon, five occuring on both the North American and Asian continents (sockeye, pink, chum, Chinook, and coho) and two (masu and amago) only in Asia. The life cycle of the Pacific salmon begins in the autumn when the adult female deposits eggs that are fertilized in gravel beds in rivers or lakes. The young emerge from the gravel the following spring and will either migrate immediately to salt water or spend one or more years in a river or lake before migrating. Migrations in the ocean are extensive during the feeding and growing phase, covering thousands of kilometres. After one or more years the maturing adults find their way back to their home river, returning to their ancestral breeding grounds to spawn. They die after spawning, and the eggs in the gravel signify the beginning of a new cycle. Upon this theme Pacific salmon have developed many variations, both between as well as within species. Pacific Salmon Life Histories provides detailed descriptions of the different life phases through which each of the seven species passes. Each chapter is written by a scientist who has spent years studying and observing a particular species of salmon. Some of the topics covered are geographic distribution, transplants, freshwater life, ocean life, development, growth, feeding, diet, migration, and spawning behaviour. The text is richly supplemented by numerous maps, illustrations, colour plates, and tables and there is a detailed general index, as well as a useful geographical index. This

Loons (Gavia spp.) were counted during the Alaska-Yukon Waterfowl Breeding Population Survey from 1971 to 1993 and the Arctic Coastal Plain Waterbird Breeding Population Survey from 1986 to 1993. Population indices for Alaska (not corrected for visibility bias) are presented by species for boreal forest, tundra, and both habitats combined. Minimum mean population estimates (1977-1993) with 95% confidence intervals were 15,360 (±2,235) Red-throated Loons (G. stellata), 69,498 (±5,596) Pacific Loons (G. pacifica), 8,886 (±843) Common Loons (G. immer) and 2,636 (±614) Yellow-billed Loons (G. adumsii). Populations of Pacific, Common and Yellow-billed Loons did

We examined the population genetic diversity and structure of sockeye salmon *Oncorhynchus nerka* spawning in tributaries of Bristol Bay, Alaska, a region that supports the largest commercial fisheries for sockeye salmon in the world. Genetic variation among the sockeye salmon populations, as revealed by microsatellite data, was shallower than that found in other areas of comparable size around the Pacific Rim. This finding was driven by similarity among populations rearing in the four largest lake systems located on the southeastern side of the bay (upper and lower Ugashik, Becharof, Naknek-Grosvenor-Coville, and Iliamna lakes). Sockeye salmon in lakes located above known obstacles to migration on the southeastern side and in tributaries on the northwestern side showed variation and structure that were more typical of the species. Management of these important fisheries assumes knowledge of the composition of stock mixtures captured in each fishery. We investigated the potential of microsatellite data to provide stock composition estimates. We examined 58 collections

Sport anglers reeling in salmon, halibut, and other fish generated--both directly and indirectly--an estimated three percent of jobs and payroll in Alaska in 1993. This is one of the findings of a study of the economics of sport fishing that ISER did for the Alaska Department of Fish and Game. Sport fishing is enormously popular with residents and visitors. The Department of Fish and Game estimates that nearly half a million anglers fished in Alaska in 1997, with numbers of visiting anglers slightly edging Alaskan anglers. Seven out of ten Alaska households have at least one sport angler. Nearly half of Alaska's households rate hunting and fishing opportunities as important reasons why they live where they do. The department contracted with ISER to do this study because the economics of sport fishing in Alaska is an important consideration for resource managers allocating fish stocks, evaluating fishery projects, and making decisions about land and water management. The analysis is based largely on information we collected in surveys of sport anglers and guide and charter businesses in 1993 and 1994. It's not entirely clear how sport fishing has changed since 1993. The Department of Fish and Game reports that the number of resident licenses stayed roughly the same, while the number issued to nonresidents grew about 25 percent. But at the same time, the department also reports that measures of fishing pressure-angler-days fished and numbers of fishing trips--have not changed substantially since 1993. There is some evidence that the growing number of visiting anglers may be mostly casual anglers, who fish once or twice while they're in Alaska. Numbers of sport charters operating in Southcentral and Southeast Alaska increased sharply in the 1990s, and many customers of those charters are tourists who buy single-day licenses. So the overall economic contribution of sport fishing may not have changed substantially since our survey. In any

The map area was impacted by Pleistocene-age glaciers derived from two principal sources. Glacier ice flowed southwestward down the Lake Clark structural trough, then split into separate ice tongues that penetrated the map area from the north and northeast. A second major ice body probably overflowed westward from Cook Inlet, filling Iliamna Lake basin and expanding into southern parts of the map area. At various times, these glaciers blocked each of the major drainages in the map area, creating ice-dammed lakes. These former lakes are indicated by broad expanses of unusually smooth, poorly drained, and gently sloping terrain that terminate abruptly upslope at consistent altitudes and are commonly bordered by wave- cut notches and by beach and deltaic deposits. At least four episodes of glaciation are recognized in the map area. The oldest is marked by ice-abraded uplands with thin patches of drift and by a conspicuous moraine in the southwestern corner of the map area. The younger three glacial advances correspond to the three oldest stades of the Brooks Lake glaciation, which Detterman and Reed (1973) equate with the late Wisconsin glacial substage of the North American glacial succession. This interval is dated at about 26,000 to 10,000 radiocarbon years before present (14C yr BP) elsewhere on the Alaska Peninsula (Stilwell and Kaufman, 1996) and in the upper Cook Inlet region (Reger and Pinney, 1997). During each of the two oldest stades, termed Kvichak and Iliamna by Detter- man and Reed (1973), glaciers filled the Lake Clark trough and coalesced with the much larger glacial lobe that filled the basin of Iliamna Lake. Glaciers entered the map area from both north and south at those times. During the subsequent Newhalen stade, glaciers extended only short distances southwest and south of Lake Clark; they penetrated only the extreme northeastern corner and east-central margin of the map

Active exchanges of water and dissolved material between the stream and groundwater in many porous sand- and gravel-bed rivers create a dynamic ecotone called the hyporheic zone. Because it lies between two heavily exploited freshwater resources—rivers and groundwater—the hyporheic zone is vulnerable to impacts coming to it through both of these habitats. This review focuses on the direct and indirect effects of human activity on ecosystem functions of the hyporheic zone. River regulation, mining, agriculture, urban, and industrial activities all have the potential to impair interstitial bacterial and invertebrate biota and disrupt the hydrological connections between the hyporheic zone and stream, groundwater, riparian, and floodplain ecosystems. Until recently, our scientific ignorance of hyporheic processes has perhaps excused the inclusion of this ecotone in river management policy. However, this no longer is the case as we become increasingly aware of the central role that the hyporheic zone plays in the maintenance of water quality and as a habitat and refuge for fauna. To fully understand the impacts of human activity on the hyporheic zone, river managers need to work with scientists to conduct long-term studies over large stretches of river. River rehabilitation and protection strategies need to prevent the degradation of linkages between the hyporheic zone and surrounding habitats while ensuring that it remains

Behavioral avoidance of copper (Cu), cobalt (Co), and a Cu and Co mixture in soft water differed greatly between rainbow trout (*Oncorhynchus mykiss*) and chinook salmon (*O. tshawytscha*). Chinook salmon avoided at least 0.7µ * Cu/L, 24 µ* Co/L, and the mixture of 1.0 *g Cu/L and 0.9 *g Co/L, whereas rainbow trout avoided at least 1.6 *g Cu/L, 180 *g Co/L, and the mixture of 2.6 µ* Cu/L and 2.4 µ* Co/L. Chinook salmon were also more sensitive to the toxic effects of Cu in that they failed to avoid *4 *g Cu/L, whereas rainbow trout failed to avoid *80 *g Cu/L. Furthermore, following acclimation to 2 _xFFFF_µg Cu/L, rainbow trout avoided 4 *g Cu/L and preferred clean water, but chinook salmon failed to avoid any Cu concentrations and did not prefer clean water. The failure to avoid high concentrations of metals by both species suggests that the sensory mechanism responsible for avoidance responses was impaired. Exposure to Cu concentrations that were not avoided could result in lethality from prolonged Cu

The freshwater streams of the Bristol Bay drainages support important subsistence and commercial salmon fisheries and internationally-famous sport fisheries for both resident species and salmon. Northern Dynasty Mines, Inc. (NDM) has proposed to mine a metallic sulfide deposit at the headwaters of some of these streams. The project, referred to as Pebble Mine, will have a preliminary lifespan of 40 to 50 years, or even longer. Applications filed by NDM in 2006 indicate that the proposed project will leave permanent landscape features affecting some thirty square miles, including two tailings ponds that will house billions of tons of mine tailings which will include toxic materials. The project will also include a 104-mile access road, with a slurry line and a water line that will directly affect at least 12.5 square miles and a power transmission line. The 2006 applications help identify potential impacts on the fish habitat and fisheries. Categories of these potential impacts of Pebble Mine on fish habitat and fishery resources include: direct, indirect, and cumulative effects. Direct impacts will result from the approximately 30 square mile footprint of the mine, processing plant, and tailings ponds; more than 60 lineal miles of mainstem streams--plus the adjacent tributaries and wetlands--that will be totally or partially dewatered; the 12.5 square miles or 8,000 acres of disturbance from the access road; port facilities; and, power production and power supply lines. Siltation caused by road-building activities will smother fish food organisms and incubating eggs and alevins. Direct effects associated with the road also include fragmentation of aquatic, riparian, and terrestrial habitats. Indirect impacts will include increased pressure on, and competition for, fish and wildlife resources, because of the increased access to the area and increased population. Cumulative impacts will include long-term, multi-year losses of fish production and stream productivity. Over time, bridges and culverts in the access road can deteriorate and interfere with juvenile or adult fish migration between important habitats. Dust and silt from the road during the life of the project or leakage from the slurry line may smother fish food organisms and incubating fish eggs and could wash downstream to affect spawning and rearing habitat in Iliamna Lake. In addition, the weight of the roadbed and traffic can be expected to compact the soil and alter the movement of groundwater which could disrupt beach

This study assessed the summer diet and consumption patterns of harbor seals (*Phoca vitulina*) resident in Iliamna Lake, Alaska. The authors predicted that adult sockeye salmon (*Oncorhynchus nerka*), a seasonally abundant and nutrient-rich prey source, would dominate diets when available and that seals would preferentially consume the most energetically profitable portion of salmon carcasses. Diet was examined by identifying hard parts of prey found in harbor seal scats, and consumption patterns were measured by collecting carcasses of harbor seal-killed sockeye salmon along island spawning grounds. Salmonids were present in 98% of scats that contained identifiable prey, followed by petromyzontids, osmerids, cottids, coregonids, and gasterosterids. The carcass surveys provided evidence of selective consumption patterns of sockeye salmon body parts. Harbor seals consumed the bodies of nearly all (96.6%) male salmon collected, leaving little but the head. In contrast, the belly and eggs were consumed in 63.6% of the female samples, and the entire body was eaten in only 31.3% of females. The harbor seals in Iliamna Lake thus took advantage of the seasonally abundant adult
None
Seepage water and drainage water geochemistry (pH, EC, O2, redox, alkalinity, dissolved cations and trace metals, major anions, total element concentrations) were studied at two active sulphide mine tailings impoundments in Finland (the Hitura Ni mine and Luikonlahti Cu mine/talc processing plant). The data were used to assess the factors influencing tailings seepage quality and to identify constraints for water treatment. Changes in seepage water quality after equilibration with atmospheric conditions were evaluated based on geochemical modelling. At Luikonlahti, annual and seasonal changes were also studied. Seepage quality was largely influenced by the tailings mineralogy, and the serpentine-rich, low sulphide Hitura tailings produced neutral mine drainage with high Ni. In contrast, drainage from the high sulphide, multi-metal tailings of Luikonlahti represented typical acid mine drainage with elevated contents of Zn, Ni, Cu, and Co. Other factors affecting the seepage quality included weathering of the tailings along the seepage flow path, process water input, local hydrological settings, and structural changes in the tailings impoundment. Geochemical modelling showed that pH increased and some heavy metals were adsorbed to Fe precipitates after net alkaline waters equilibrated with the atmosphere. In the net acidic waters, pH decreased and no adsorption occurred. A combination of aerobic and anaerobic treatments is proposed for
A classic example of a sustainable fishery is that targeting sockeye salmon in Bristol Bay, Alaska, where record catches have occurred during the last 20 years. The stock complex is an amalgamation of several hundred discrete spawning populations. Structured within lake systems, individual populations display diverse life history characteristics and local adaptations to the variation in spawning and rearing habitats. This biocomplexity has enabled the aggregate of populations to sustain its productivity despite major changes in climatic conditions affecting the freshwater and marine environments during the last century. Different geographic and life history components
Many of Alaska's salmon fisheries are models of biological success, with management structures that have maintained biomass, stock diversity, and biological yield. At the same time the fisheries face severe challenges due to low product price, and have been declared formal "economic" disasters by state and federal agencies in recent years. From many perspectives, these fisheries are in crisis. I explore how the governance system for Alaska's Bristol Bay fishery has led to biological success and economic failure. I review a range of alternative governance structures, in place or being considered, that might provide for social and economic sustainability. I also demonstrate

We quantified the amount, spatial distribution, and importance of salmon *(Oncorhynchus* sp.)-derived nitrogen (N) by brown bears (*Ursus arctos*) on the Kenai Peninsula, Alaska. We tested and confirmed the hypothesis that the stable isotope signature (δ15N) of N in foliage of white spruce (*Picea glauca*) was inversely proportional to the distance from salmon-spawning streams ($r=-0.99$ and $P<0.05$ in two separate watersheds). Locations of radio-collared brown bears, relative to their distance from a stream, were highly correlated with δ15N depletion of foliage across the same gradient ($r=-0.98$ and -0.96 and $P<0.05$ in the same two separate watersheds). Mean rates of redistribution of salmon-derived N by adult female brown bears were 37.2 ± 2.9 kg/year per bear (range 23.1-56.3), of which 96% (35.7 ± 2.7 kg/year per bear) was excreted in urine, 3% (1.1±0.1 kg/year per bear) was excreted in feces, and <1% (0.3 ± 0.1 kg/year per bear) was retained in the body. On an area basis, salmon-N redistribution rates were as high as 5.1 ± 0.7 mg/sq.-m per year per bear within 500 m of the stream but dropped off greatly with increasing distance. We estimated that 15.5-17.8% of the total N in spruce foliage within 500 m of the stream was derived from salmon. Of that, bears had

State-owned lands on the Bristol Bay coastal plain in southwest Alaska have been opened for oil and gas exploration. This area encompasses numerous small lakes and ponds on the Nushagak and Alaska peninsulas. To date, there have been few data collected describing the fish species or subsistence use of the small tundra ponds in the region. During 2006, a pilot project was completed to sample fish communities in selected small tundra ponds near King Salmon, Alaska. Nineteen ponds were surveyed during early summer, and fish were found in all ponds with depths greater than 0.9 m. Alaska blackfish *Dallia pectoralis* were the most abundant and wide-spread species encountered and were found in all but one pond where fish were present. Ninespine stickleback *Pungitius pungitius* were captured in five ponds and threespine stickleback *Gasterosteus aculeatus* were captured in four ponds. Northern pike *Esox lucius*, longnose sucker *Catostomus catostomus*, and pond smelt *Hypomesus olidus* were also encountered, but each species was only found in single ponds. Our sampling methods may not have been sufficient to capture all species present. The most productive sampling gears were multifilament experimental gillnets and baited minnow traps. Our sampling during 2006 suggested that, for the tundra ponds we examined, those that do not experience winterkill should support fish populations even though all of the ponds we surveyed were small (< 0.5 sq.-km), shallow (< 2.5 m), and had no temporally continuous outlets connecting them to streams. Future work should provide an inventory of the size and number of tundra ponds in areas of interest and representatively sample those ponds, including larger, deeper ponds that may be providing rearing habitat for

A large barren-ground caribou (*Rangifer tarandus granti*) population (the Bering Seacoast Herd) historically ranged across southwest Alaska. The size of this herd peaked in the early 1860s but declined by the late 1880s. Caribou numbers remained low in southwest Alaska for the next 100 years. Biologists have argued that periodic dispersal has been an important factor in caribou population dynamics. However, others conclude there was no credible evidence that significant interchange between herds has ever occurred in Alaska. Since 1981, we monitored 318 radiocollared caribou and documented dramatic population growth, erratic movements, shifts from traditional ranges, and changes in migratory behavior. We also documented shifts in calving distribution that may contrast with conventional concepts of calving tradition and herd identity. Some biologists have concluded caribou herds can be considered closed populations for management purposes because the number of dispersing caribou is so small that it has no influence on population dynamics. We propose that the current

We manipulated, in accord with global-warming predictions, the thermal regime of a permanent first-order stream near Toronto, Ontario, Canada. We examined the effects of a 2-3.5°C water-temperature increase on densities, biomass, species composition, and life histories of resident stream invertebrates. The stream was divided longitudinally at the source into two channels, one control and one experimental, and a before and after (BACI) design was employed such that one pre-manipulation year was followed by 2 yr of the temperature manipulation. Changes in the experimental channel following commencement of the manipulation included: (1) decreased total animal densities, particularly Chironomidae (Diptera); (2) earlier onset of adult insect emergence; (3) increased growth rates and precocious breeding in *Hyalella azteca* (Amphipoda); (4) smaller size at maturity for *Nemoura trispinosa* (Plecoptera) and *H. azteca*; and (5) altered sex ratios for *Lepidostoma vernale* (Trichoptera). These results partially corroborate previous laboratory and field studies. However, variation in the responses of individual target species to the manipulation was unexpected and may have been

The goal of this project was to estimate harvests of caribou (primarily the Mulchatna and Nushagak Peninsula herds), moose, black bear, brown bear, and Dall sheep (collectively identified as "large land mammals" in this report) by residents of the communities of the western Bristol Bay Area in Game Management Units (GMU) 9B and 17 (Figure 1). The research was modeled after the Northern Alaska Peninsula Large Land Mammal Project conducted jointly by the Division of Subsistence of the Alaska Department of Fish and Game (ADFG) and the Natural Resource Department of the Bristol Bay Native Association (BBNA) (Krieg et al. 1996, Krieg et al. 1998). This project was also conducted by ADFG and BBNA. It was funded through a cooperative agreement with the US Fish and Wildlife Service (FWS Agreement Number 701811J3557; ADF&G Number COOP 01-073). Using local research assistants hired by BBNA, household interviews were conducted to collect harvest and use information for large land mammals. Hunters also mapped areas used to hunt and harvest these species. Study communities were Aleknagik, Clarks Point, Dillingham, Ekwok, Igiugig, Iliamna, Kokhanok, Koliganek, Levelock, Manokotak, Newhalen, New Stuyahok, Nondalton, Pedro Bay, Portage Creek, Port Alsworth, Togiak, and Twin Hills (Figure 1). Key respondent interviews were also conducted in Unit 9B to document their traditional ecological knowledge (TEK) relating to

We summarized studies on the impacts and scale effects of negative (competition, predation, parasitism, herbivory) and positive (mutualism, commensalism, indirect facilitation) species interactions in freshwater benthic habitats since ,1986 and focused on organisms with mainly or entirely aquatic life cycles. Benthologists publishing in J-NABS have contributed robustly to our overall knowledge of predation and herbivory but less so of other species interactions. Predators can limit the abundance of benthic prey and affect prey size or age structure, behavior, and morphology, and these effects can be transmitted through food webs and ecosystems. Herbivores can limit biomass of benthic algae, alter physiognomy, species composition and diversity, and stoichiometry, and exert strong indirect effects within food webs and nutrient cycles. Parasites can alter host behavior or morphology, but few studies have shown that lethal/sublethal effects of parasites on their hosts have population- or community-scale consequences. Fishes and macroinvertebrates occasionally experience competition, but the effect of competition on demographies and assemblages appears restricted to local scales, perhaps because competition can be modulated by many biotic (bioenergetic efficiency, parasitism, predation) and abiotic (floods, drought, resource distribution) factors. Positive interactions have been the least studied species interaction by benthologists, but interest is growing. Future study of population-scale positive interactions and nontraditional interactions at larger scales (e.g., riparian effects on benthic habitat stabilization, cross-

The Aznalcollar tailings dam at Boliden Apirsa's Aznalcollar/Los Frailes Ag–Cu–Pb–Zn mine 45 km west of Seville, Spain, was breached on 25 April 1998, flooding approximately 4600 hectares of land along the Rıos Agrio and Guadiamar with approximately 5.5 million cubic meters of acidic water and 1.3x10^6 cubic m of heavy metal-bearing tailings. Most of the deposited tailings and approximately 4.7X10^6 cubic m of contaminated soils were removed to the Aznalcollar open pit during clean-up work undertaken immediately after the spill until January 1999. Detailed geomorphological and geochemical surveys of the post-clean-up channel, floodplain and valley floor, and sediment and water sampling, were carried out in January and May 1999 at 6 reaches representative of the types of river channel and floodplain environments in the Rıo Guadiamar catchment affected by the spill. The collected data show that the clean-up operations removed enough spill-deposited sediment to achieve pre-spill metal (Ag, As, Cd, Cu, Pb, Sb, Tl, Zn) concentrations in surface sediment. These concentrations, however, are still elevated above pre-mining concentrations, and emphasise that mining continues to contaminate the Agrio-Guadiamar river system. Dilution by relatively uncontaminated sediment appears to reduce metal concentrations downstream but increases in metal and As concentrations occur downstream, presumably as a result of factors such as sewage and agriculture. River water samples collected in May 1999 have significantly greater dissolved concentrations of metals and As than those from January 1999, probably due to greater sulphide oxidation from residual tailings with concomitant release of metals in the warmer early summer months. These concentrations are reduced downstream, probably by a combination of dilution and removal of metals by mineral precipitation. Single chemical extractions (de-ionised water, CaCl2 0.01 mol/l, CH3COONH4 1 M, CH3COONa 1 M and ammonium oxalate 0.2 M) on alluvial samples from reaches 1 and 6, the tailings, pre-spill alluvium and marl have shown that the order of sediment-borne contaminant mobility is generally Zn>Cd>Cu>Pb>As. Pb and As are
Many explanations for diversity patterns have been proposed, and there have been several recent reviews of the subject (Pianka 1966, 1974; Ricklefs 1973; Pielou 1975). High diversity has been attributed both to intense competition which forces niche restriction (Dobzhansky 1950; MacArthur and Wilson 1967) and negatively correlated with productivity (Yount 1956; Margalef 1969). The question is far from settled. This paper develops an approach to the problem of species diversity based on the nonequilibrium interactions of competing populations. Under nonequilibrium conditions, differences in diversity are strongly influenced by variations in the rates of competitive displacement between communities, and such factors as relative competititve abilities, niche partitioning, etc., may not be particularly important. This approach deals primarily
None
None
Limited entry permit holdings, fishery harvests, and estimated gross earnings are broken out by resident type for the Bristol Bay salmon drift gillnet and set gillnet fisheries. Three resident types are considered: persons who reside in places local to Bristol Bay; persons who reside in Alaska, but in places outside of Bristol Bay; and persons who are nonresidents of Alaska. The resident status for a permit is determined by the residence of the end-of-the year permit holder. This report also contains a description of the

As long linear ecosystems, rivers and streams are particularly vulnerable to fragmentation. There is growing concern about the role of road crossings – and especially culverts – in altering habitats and disrupting river and stream continuity. Most of the culverts currently in place were designed with the principal objective of moving water across a road alignment. Little consideration was given to ecosystem processes such as the natural hydrology, sediment transport, fish and wildlife passage, or the movement of woody debris. It is not surprising then that many culverts significantly disrupt the movement of aquatic organisms. Survival of individual animals, facilitation of reproduction, and the maintenance of population continuity are important functions of movement at a population level. Dispersal of individuals provides a mechanism for regulating population density. These dispersing individuals maintain gene flow among populations and may supplement populations where recruitment is unable to keep pace with the loss of individuals. For many small species (especially invertebrates), dispersal of individuals provides a mechanism for colonizing habitat, allowing local populations to come and go as habitat is created or eliminated, while maintaining viable regional populations. Much attention has been focused on passage for migratory fish, especially in the northwestern U.S. In some cases, considerable resources have been invested in projects addressing fish passage only to find that accommodations made for adults did not address the needs of juvenile fish. Long-term conservation of fish resources will depend not only on passage for both adult and juvenile fish but also on maintenance of healthy stream and river ecosystems. Essential to this approach is a focus on habitat quality and strategies for aquatic organism passage based on communities rather than individual species. Without an ecosystem-based approach to river and stream crossings we will be at risk of facilitating passage for particular fish species while at the same time undermining the ecological integrity of the ecosystems on which these fish depend. Stream simulation is an approach to culvert design that both avoids flow constriction during normal conditions and creates a stream channel within culverts that resists scouring during flood events. Designing culverts to avoid channel constriction and to maintain appropriate channel conditions within the structure is a relatively simple and

Pacific walruses (*Odobenzs rosmarzs divergens*) make trips from ice or land haul-out sites to forage for benthic prey. We describe dive and trip characteristics from time-depth-recorder data collected over a one-month period during summer from four male Pacific walruses in Bristol Bay, Alaska. Dives were classified into four types. Shallow (4 m), short (2.7 min), square-shaped dives accounted for 11% of trip time, and many were probably associated with traveling. Shallow (2 m) and very short (0.5 min) dives composed only 1% of trip time. Deep (41 m), long (7.2 min), square-shaped dives accounted for 46% of trip time and were undoubtedly associated with benthic foraging. V-shaped dives ranged widely in depth, were of moderate duration (4.7 min), and composed 3% of trip time. These dives may have been associated with navigation or exploration of the seafloor for potential prey habitat. Surface intervals between dives were similar among dive types, and generally lasted 1-2 min. Total foraging time was strongly correlated with trip duration and there was no apparent diel pattern of diving in any dive type among animals. We found no correlation between dive duration and postdive surface interval within dive types, suggesting that diving occurred within aerobic

Satellite radio-location data from 57 adult male Pacific walruses (*Odobenus rosmarus divergens*) were used to estimate haul-out fidelity, broadly describe seasonal foraging distributions, and determine the approximate timing of autumn migration from Bristol Bay, Alaska. Data were collected intermittently during 1987-91 and 1995-2000, primarily during the period from May to October. Transmitter longevity ranged from less than 1 day to 560 days (median 75 d). The four tagging sites were the only haul-outs that were commonly used in the bay from spring through autumn. Mean fidelity, defined as the chance that an animal will return to an area where it previously hauled out, was 0.56 (SE = 0.09). However, small sample sizes precluded comparisons of fidelity among years and among haul-outs by season. No tagged animals migrated out of the bay between spring and early autumn. Combined monthly locations suggest that foraging occurred primarily in the southern and eastern areas of the bay in spring and gradually shifted towards northwestern areas in late autumn and winter. Ninety-eight percent of the in-water locations were in waters under 60 m deep, which account for 76% of the study

Since 1977, the Alaska Department of Fish and Game has conducted an annual mail survey to estimate sportfishing participation and harvests (fish kept) statewide by Alaskan fisheries, areas, regions, and species. Since 1990, catches (fish and clams harvested plus fish released) have also been estimated. Detailed findings are presented for 2001. In 2001, an estimated 432,129 anglers fished 2,261,941 days and kept 3,078,100 of the 6,775,786 fish and clams caught. The 3,216,432 fish harvested in 2002 included 788,665 razor clams *Siliqua patula* and 96,304 smelt and capelin Osmeridae. Of the remaining 2,331,463 harvested fish, 1,523,338 (65.3%) were anadromous (sea-run) salmon *Oncorhynchus*, 350,809 (15.1%) were Pacific halibut *Hippoglossus stenolepis*, 120,398 (5.2%) were rockfish Sebastes, 117,063 (5.0%) were rainbow trout *O. mykiss*, 60,994 (2.6%) were Dolly Varden *Salvelinus malma* and Arctic char *Salvelinus alpinus*, 37,910 (1.6%) were Arctic grayling *Thymallus arcticus*, and 38,498

None

To learn more about mid-Pacific migration, we radio-tagged 40 Pacific Golden-Plovers (*Pluvialis fulva*) in spring 1999 on their wintering territories in Hawaii. The birds departed in late April, and with aerial monitoring we relocated 10 of them in Alaska. Seven individuals were in or near the Nushagak River lowlands in southwestern Alaska. Nesting Pacific Golden-Plovers were discovered there in 1994 disjunct from the previously known breeding range. The remaining three radio-tagged birds were found north of Bethel on the Yukon-Kuskokwim Delta. Our results suggest that breeding is continuous from the Nushagak region west through the uplands north of Bristol Bay to the Yukon-Kuskokwim Delta. Thus plovers wintering in Hawaii apparently nest across a wide area of Alaska. We present a revised Alaska breeding distribution map for the species which differs significantly from AOU Checklist boundaries. The temporary attachment of transmitters (they are shed during summer molting) had no apparent effect on survival within our

Much research has been devoted to the effects of acidic runoff episodes on populations of brook trout *Salvelinus fontinalis*. Less is known about slimy sculpin *Cottus cognatus* and why their numbers have declined in acidified streams. Adult tolerance of low pH and aluminum (Al) toxicity is similar in these two species. Slimy sculpin spawn in the spring, when high stream flows elevate concentrations of toxic Al and decrease stream pH in acid-sensitive watersheds. We hypothesized that acidic episodes in spring were a source of stress for slimy sculpin and hindered their reproduction. We tested this hypothesis by examining the mortality, behavior, whole-body sodium concentrations, and spawning among slimy sculpin exposed to ambient conditions during the spring spawning period in two Pennsylvania streams, Stone Run (an episodically acidified stream that formerly contained slimy sculpin) and Benner Run (a stream with slimy sculpin that does not experience severe acidic episodes). Our hypothesis was supported by the higher mortality, hypoactivity, lower body sodium concentrations, and lack of spawning among slimy sculpin in Stone Run relative to those in Benner Run. Reproductive disturbance

Little is known of how fish respond to the hydraulic environment associated with diversion or bypass structures at hydroelectric power installations. To address this lack of knowledge, this paper presents results from a study to assess how three species of Pacific salmonid smolt (*Oncorhynchus* spp.) responded to distinct gradients of velocity and depth associated with two submerged weirs as they passed through an experimental flume at McNary Dam (Columbia River, USA) under illuminated and dark conditions. Migrating smolts entered one of two available treatment channels as coherent schools from which individuals would either disassociate from the group and pass over the weirs, or would reject them by swimming upstream. Alternatively, fish maintained position at the upstream end of the flume by swimming into the flow. The response of smolts to velocity and depth gradient and light condition varied between species, and route of passage was influenced by fork length. Initial channel selection and school size was not influenced by weir type, although schools resided longer within the short-weir channel. The majority of smolts (70%) entered the treatment channels facing downstream (negative rheotaxis), but switched orientation at the crests of the weirs. This switch in orientation occurred farther downstream in the short-weir treatment and for the largest

1. Warming trends are evident in many parts of the globe but are especially marked at higher latitudes, with complex effects on the biota that include direct effects on growth potential and indirect effects through food webs; 2. Air temperatures have been increasing over the past 50 years in southwestern Alaska, affecting the growth and population dynamics of many organisms, including a variety of aquatic species such as the freshwater mussel *Anodonta beringiana*; 3. We collected freshwater mussels from Iliamna Lake, in the Bristol Bay region of Alaska, and measured their shells to examine climatic effects on growth patterns; 4. Linear mixed effects models and ordinary least square linear regressions revealed strong positive correlations between local air temperatures (especially in May, October and the summer months) and inter-annual variation in mussel growth. Slower mussel growth was also significantly correlated with

Biota δ15N and δ13C values (deviations from recognized isotope standards) from Iliamna Lake (a major anadromous sockeye salmon (*Oncorhynchus nerka*) nursery lake supporting peak-year runs >10 million) and several other anadromous-salmon-free lakes in the Kvichak River watershed, Bristol Bay, southwestern Alaska, were compared to determine the significance of marine-derived nitrogen (MDN) delivered by returning adult salmon. Biota in Iliamna Lake had higher δ15N compared with control lakes, verifying a mixing model correlating δ15N with MDN. Periphyton δ15N values reflected localized input from populations of spawning salmon. Juvenile sockeye MDN varied in response to escapement size, suggesting the importance of large escapements (>10 million) for maintaining a predominantly MDN lacustrine N pool. Other resident fishes showed shifts in δ15N between years of high and low escapement. The dual-isotope approach, using δ15N and δ13C together, suggested that fish production is primarily dependent on limnetic primary and secondary production. The dual-isotope approach indicated that the

The Commercial Fisheries Entry Commission (CFEC) requested this study for help in forecasting future ex-vessel prices of Bristol Bay sockeye salmon. CFEC plans to use the forecasts in analyzing the "optimum number" of limited entry permits in the Bristol Bay drift gillnet salmon fishery. The study describes markets for Bristol Bay sockeye salmon products and how market conditions affect ex-vessel prices. The study develops an equation for forecasting future sockeye salmon ex-vessel prices based on assumptions about future Bristol Bay harvests and future farmed salmon wholesale

The Pebble Project is a proposed copper-gold-molybdenum mine, processing facility and associated Tailings Storage Facility (TSF) located latitude 59°53'54" and longitude 155°17'44" in the Bristol Bay region of southwest Alaska, approximately 238 miles southwest of Anchorage and 17 miles northwest of the Village of Iliamna. It is situated within Iliamna D6 and D7 topographic maps in Townships 3 to 5 South, Ranges 34 to 37 West in the Seward Meridian. Northern Dynasty Mines Inc., the project owner, is developing the project, and has engaged Knight Piésold Ltd. to design the TSF, which includes the staged construction of confining dams.
The procedures for applications to construct a dam are outlined in Chapter 5 of the Guidelines for Cooperation with the Alaska Dam Safety Program, dated June 2005, (the "Guidelines") published by the Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land and Water Resources of the Alaska Department of Natural Resources. This report constitutes the Initial Application Package for submission under the Alaska Dam Safety Program as the first step towards receipt by Northern Dynasty Mines Inc. of a Certificate of Approval to Construct a Dam.
The proposed impoundment will incorporate three embankment structures in the South Fork Koktuli River situated near the headwaters as follows:
o A north embankment that will be progressively raised in a series of staged expansions to an ultimate height of 700 feet,
o A southeast and southwest embankment that will be constructed in stages to an ultimate height of 710 feet and 740 feet, respectively.
Knight Piésold Ltd. has carried out a Hazard Potential Classification of the dams, based on the classifications set out in the Guidelines. The resulting preliminary classification for each of the dams is Class II (Significant). However, Northern Dynasty Mines Inc. is planning to incorporate more stringent design criteria for flood and earthquake events consistent with a Class I (High) classification.
This report provides a project description; an assessment of the site characteristics with

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The proposed impoundment will incorporate two embankment structures in an Unnamed Tributary (NK1.190) situated near the headwaters of the North Fork Koktuli River as follows:
o A main starter dam that will be progressively raised in a series of staged expansions to an ultimate height of 450 feet,
o A lower saddle dam will be constructed in stages to an ultimate height of 175 feet to provide for storage capacity during the latter years of operation.
Knight Piésold Ltd. has carried out a Hazard Potential Classification of the dams, based on the classifications set out in the Guidelines. The resulting preliminary classification for each of the dams is Class II (Significant). However, Northern Dynasty Mines Inc. is planning to incorporate more stringent design criteria for flood and earthquake events consistent with a Class I (High) classification.

Sustainable Fisheries Management: Pacific Salmon clearly articulates the current state of the Pacific Salmon resource, describes the key features of its management, and provides important ideas and suggestions on how we can make the transition toward sustainable fisheries. The solutions presented in this book provide the basis of a strategy for sustainable fisheries, requiring society and government agencies to establish

None

The project collected information about subsistence harvests of nonsalmon freshwater fish by residents of the eight communities of the Kvichak River watershed of the Bristol Bay area, southwest Alaska, for a 12-month period from October 2002 through September 2003. Local research assistants were hired and trained to collect harvest calendars from participating households and conduct a post-season harvest survey. Data were collected on amounts harvested, gear types used, timing of harvests, and location of harvests. There was a high level of involvement in the subsistence use of nonsalmon fish in the study communities, although harvests were low compared to previous estimates from the 1970s, 1980s, and 1990s, primarily because the unusually warm winter in 2002/2003 inhibited travel and the use of traditional methods such as ice fishing. Also, TEK interviews were conducted with 28 individuals, covering such topics as

None

Annual spring aerial surveys were initiated in 1992, and repeated in 1993, 1994, 1997, 1998, 2000-2005 and 2007 to monitor the population status of and habitat use by Steller's eiders (*Polysticta stelleri*) staging for spring migration in southwestern Alaska. Since the timing of migration varies, two to three replicate shoreline surveys were conducted each survey year through 1997, to target the optimal timing when most eiders were within the survey area prior to departure to arctic breeding grounds. Fiscal constraints and inclement weather in subsequent years resulted in successful completion of only one survey per year, the timing of which was carefully scheduled using sea ice, weather and observational data from local contacts. We made visual estimates of Steller's eiders and all other identifiable water birds and marine mammals along shorelines, estuaries and shoals where Steller's eiders and other seaducks were known to congregate during migration. In each year where multiple surveys were completed, the highest Steller's eider count was used as that year's population estimate for trend analysis. Annual Steller's eider raw counts are 137,904 (1992); 88,636 (1993); 107,589 (1994); 90,269 (1997), 84,459 (1998), 68,956 (2000), 58,231 (2001), 54,191 (2002), 77,329 (2003), 82,455 (2004), 79,022 (2005) and 87,353 (2007). The long-term average from 1992 to 2007 is 84,700. Correcting recent estimates using extrapolated data from sampled shoal habitats, the totals are 72,953 (2000), 60,656 (2001), 56,704 (2002), 77,369 (2003), 82,772 (2004), 79,022 (2005), and 87,400 (2007). We suspect that the low population estimates obtained from 2000 through 2002 were due in part to a portion of the eiders migrating northward during the survey, thus escaping detection by the survey crew. This hypothesis was supported by satellite telemetry data which indicated migration within the study area during the survey of 2002. We therefore initiated the 2003 through 2007 surveys in early April, encountering most eiders before they moved from Alaska Peninsula lagoons to Kuskokwim Bay and other more northerly habitats. Unexpanded long-term survey data indicate a 2.8 percent average annual decline in

Juvenile rainbow trout were exposed to 25-400 µg copper□L^{-1} for 24h. Water hardness, pH, and alkalinity were varied independently at a constant [Na^+]. Net and unidirectional sodium fluxes were measured in hard and soft, low-alkalinity water and in hard, high-alkalinity water at neutral pH and pH 5.0. In low alkalinity water, Na^+ uptake (J_{in}) was inhibited at copper concentrations as low as 25 µg□L^{-1}, and sodium efflux (J_{out}) was stimulated above 100 µg□L^{-1}. High-alkalinity water significantly reduced the effects of copper on J_{in} and J_{out} but there was no significant effect of increasing water hardness. The effects of pH 5.0 and copper were additive from 25 to 100 µg□L^{-1}, but a pure copper effect was found from 200 to 400 µg□L^{-1}. Fish died when they had lost about 50-55% of their exchangeable Na+ pool. Water hardness and alkalinity had no effect on the

The purpose of this guide is to provide assistance to visitors to the Southwest Alaska Network (SWAN) national parks and National Park Service staff in identifying, understanding, and enjoying bivalves found in intertidal sediments in the SWAN parks. We have provided brief sections on the ecology of these clams, including comments on their habitats and feeding types, and a descriptive guide to the clams. The descriptive guide includes drawings and photographs to depict the appearance of the clams both in the hand and, where possible, the appearance of distinguishing indicators of their presence in the field. For each species, we have included a brief description of the clam, its typical habitat, and its distribution among the parks and in the North Pacific. Bivalves are a critical source of nutrition for major predators such as bears, sea otters, sea (diving) ducks, shorebirds and other invertebrates at some time during the year. For example, bears along the KATM coast achieve higher rates of energy from razor and softshell clams than those foraging on vegetation (Smith 2004). In addition to supporting the bears, sea otters, diving ducks, and shorebirds for millions of years, clams have been a major source of food for native Alaskans since their arrival in Alaska 15,000 to 20,000 years ago. They have been important in the success of native cultures in coastal environments. Clams exhibit longevity and lack of mobility, and thus are good indicators of long-term conditions (Bennett 2006). It can be assumed that beaches supporting reasonable numbers of longlived clams are stable and "healthy." This guide includes descriptions of twenty-nine species in thirteen families that were found in surveys of beaches in three SWAN national parks during the summers of 2004 and 2005 (Lees and Driskell 2004, 2006a, and 2006b). The parks surveyed were Katmai National Park and Preserve (KATM), Kenai Fjord National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). Species composition of the clams varied considerably by park. Approximately the same number of clam species was observed in KATM and KEFJ, but LACL supports far fewer species. Only Baltic macomas and softshell clams were found

The most comprehensive "insiders" guide on Alaska fishing, revised, updated, and expanded in this new deluxe, full color 3rd edition. Written by the state's top fishing experts, this latest version now covers all 17 major Alaska sport species (fresh and salt waters), all methods (fly, spin, and bait), and all six regions of the state, with details on over 300 of the most productive Alaska fishing locations. Includes information on regional climate/conditions, run timing, visitor service costs, trophy and record fishes, USGS map references, guides' tips, fishing regulations, etc. Bonus back section with Alaska trip planner, flies for Alaska, knots, fish filleting, and a comprehensive cross-referenced index. Has over 500 color photos, maps, charts, diagrams, and drawings.

Recent progress in the study of aquatic food-cycle relationships invites a re- appraisal of certain ecological tenets. Quantitative productivity data provide a basis for enunciating certain trophic principles, which, when applied to a series of successional stages, shed new light on the dynamics of ecological succession.

Thirty-eight aerial surveys of beluga or white whales (*Delphinapterus leucas*) were conducted in Bristol Bay, Alaska, during six different years between 1993 and 2005. Belugas were sighted mainly close to shore in the upper parts of Nushagak and Kvichak bays as well as along the coast between these bays and in the lower parts of major rivers. Data from 28 complete counts made in good or excellent survey conditions were analysed for trend. Counts ranged from 264 to 1,067. The estimated rate of increase over the 12-year period was 4.8%/year (95% CI = 2.1%-7.5%). Such a rate of increase suggests that either the population was below the environmental carrying capacity in the early 1990s or, alternatively, that factors that had been limiting population increase were alleviated after that time. A review of possible changes in human-caused mortality, predation and prey availability did not reveal a single likely cause of the increase. Among the factors that could have played it role are recovery from research kills in the 1960s, a modest decline in subsistence removals and a delayed response to increases in Pacific

We analysed the benthic macroinvertebrate species composition, taxonomic richness (as expected richness for 100 individuals), total abundance and biomass at 117 stream sites in the province of Dalarna. Partial least squares regression models were constructed from observations on undisturbed sites and used to predict these community parameters at sites exposed to elevated levels of copper, zinc, lead and cadmium resulting from leakage from old mine deposits. Species richness at undisturbed sites was positively related to the size of the catchment, pH, channel width, calcium concentration and the proportion of deciduous trees in the riparian zone. In streams with elevated metal concentrations, we found reductions in taxonomic richness for total macroinvertebrates, mayflies, stoneflies and combined EPT (Ephemeroptera, Plecoptera and Trichoptera), but not for that of Tri-choptera nor total abundance or biomass. Copper and zinc were those metals showing strongest negative associations with richness. Some taxa,

A half-century after mine closure, metal contamination from sulfide ore mining in the headwaters continues to impair riparian vegetation and aquatic macroinvertebrates along Soda Butte Creek, Yellowstone National Park. A tailings dam failure in 1950 emplaced metal-rich sediment at high flood-plain levels, above 50 yr to 100 yr flood stages in 1996 and 1997. These large natural floods removed only a small part of the contaminated sediment through bank erosion; they also failed to lower in-channel Cu concentrations, because increased erosion of mine waste during high flows balances increased inputs of uncontaminated sediments, generating no net change in concentrations. Geomorphic

In compliance with the reporting requirements associated with Fish Resource Permit No. SF-2004-114 and amendment No. SF2004-114-A-1. This report summarizes the fish sampling efforts conducted within the Pebble Gold Copper project area and along the proposed road corridor by biologists from HDR Alaska, Inc. and Northern Ecological Services. Sampling was conducted between April and October 2004. The main purpose of the study was to document the distribution, relative abundance, and variety of fish

The habitat use information and Habitat Suitability Index (HSI) models presented in this document are intended for use in impact assessment and habitat management activities. Literature concerning a species, habitat requirements and preferences is reviewed and then synthesized into subjective HSI models, which are scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat). Assumptions used to transform habitat use information into these mathematical models are noted and guidelines for model application are described. Any models found in the literature which may also be

Methodology (IFIM) will be included in this series in the near future. The IFIM section will include a discussion of Suitability Index (SI) curves, as are used in IFIM and a discussion of SI curves available for the IFIM analysis of coho salmon habitat.

Data contained in this report represent the Division's most recent efforts to upgrade and update fishery statistics useful in describing Southwestern Alaska's sport fisheries. Data contained in this document were extracted from Statewide Harvest Summaries, Survey and Inventory Reports, and the Fishery Data and Manuscript Series. We consider this report to be the most comprehensive information source concerning effort and harvest statistics for the major Southwestern Alaska sport fisheries. Fisheries data in this report supersede information in previous reports and are intended for interdepartmental use only.

This report addresses more than a dozen environmental issues arising from the hydrological and geochemical conditions at the proposed Pebble Mine, which would develop a metallic sulfide deposit in the Bristol Bay drainages of Southwest Alaska. These drainages produce a major portion of the world's sockeye salmon supply, important subsistence use, and recreation. The hydrological and geochemical issues fall into two groups. The first is "substantive" issues – e.g. (a) acid mine drainage from unprocessed waste and host rock, mine or pit walls, tailings, tailings storage facilities, and dust; (b) pollution from chemicals used in processing ore, (c) pollution from fuels, oils, greases and antifreeze; (d) pollution from residues of explosives; (e) chemical and bacteriological pollution from sewerage treatment facilities; (f) pollution from herbicides, pesticides and road deicing compounds; etc. The second group is "procedural" issues. They result from (a) inadequate data (or decisions not to release all data) particularly on matters related to hydrology and chemical compositions of rock, potential ore, waste rock, tailings, etc; (b) inadequate sampling techniques, and inadequate protocols for preserving field samples or gathering field or lab data; etc. The procedural issues weave throughout the substantive issues and undermine the ability of the public and their

In response to the guidelines established in the Sustainable Salmon Fisheries Policy (ADF&G 2000), the Alaska Department of Fish and Game (department) first classified the Kvichak River sockeye salmon *Oncorhynchus nerka* stock as a "Stock of Yield Concern" in 2001 (Bristol Bay Staff 2000). A yield concern is defined as "a concern arising from a chronic inability, despite use of specific management measures, to maintain expected yields." Classification of Kvichak River sockeye salmon was subsequently changed to a "Stock of Management Concern" in 2003. This classification change was based on the definition of "management concern" found in the policy. A "management concern" is defined as, "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for salmon stocks within the bounds of Sustainable Escapement Goal (SEG), Biological Escapement Goal (BEG), Optimal Escapement Goal (OEG), or other specified management objectives for the fishery." The increased protection provided by commercial, sport, and subsistence fisheries restrictions and closures that have occurred in recent years has been helping the Kvichak River sockeye salmon stock recover: minimum escapement goals were met during the last 5 years (2005-2009); there was a surplus harvest of Kvichak River sockeye salmon in the commercial fishery from 2005-2009; and return per spawner has

Pacific salmon *(Oncorhynchus* spp.) accumulate substantial nutrients in their bodies as they grow to adulthood at sea. These nutrients are carried to predominantly oligotrophic lakes and streams, where they are released during and after spawning. Research over more than 3 decades has shown that the annual deposition of salmon-borne marine-derived nutrients (MD-nutrients) is important for the productivity of freshwater communities throughout the Pacific coastal region. However, the pathways and mechanisms for MD-nutrient transfer and accumulation in freshwater and riparian ecosystems remain virtually unexplored, consequently, there are many uncertainties in this area. This article addresses three related topics. First, we summarize recent advances in our understanding of the linkages among MD-nutrients, freshwater (including riparian) ecosystems, and community dynamics by addressing the importance of MD-nutrients to lakes and streams and by then reviewing large scale and long-term processes in the atmosphere and ocean that govern variability in salmon populations. Second, we evaluate the validity of the discoveries and their implications for active ecosystem management, noting areas where extrapolation from these results still requires great caution. Finally, we outline five key research issues where additional discoveries could greatly augment our understanding of the processes shaping the structure and dynamics of salmon populations and the characteristics of their freshwater

None

The American Fisheries Society herein provides a list of depleted Pacific salmon, steelhead, and sea-run cutthroat stocks from California, Oregon, Idaho, and Washington, to accompany the list of rare inland fishes reported by Williams et al. (1989). The list includes 214 native naturally spawning stocks: 101 at high risk of extinction, 58 at moderate risk of extinction, 54 of special concern, and one classified as threatened under the Endangered Species Act of 1973 and as endangered by the state of California. The decline in native salmon, steelhead, and sea-run cutthroat populations has resulted from habitat loss and damage, and inadequate passage and flows caused by hydropower, agriculture, logging, and other developments; overfishing, primarily of weaker stocks in mixed-stock fisheries; and negative interactions with other fishes, including nonnative hatchery salmon and steelhead. While some attempts at remedying these threats have been made, they have not been enough to prevent the broad decline

Mineral extraction, whether it be by surface or underground mining in their diverse forms, affects salmonids and their habitats in many ways. Increasing public awareness of the value of aquatic resources has led to legislation designed to protect, restore, or enhance areas that have been or will be mined. This positive trend has also led to a growing body of knowledge about the specific effects of mining-related pollutants on salmon and trout and the mechanisms by which habitat degradation may be reversed. Some of the adverse effects of mining on salmonid habitats are obvious. Placer mining converts natural streams to channels between barren rubble piles; hydraulic mining erodes hillsides and deposits the eroded material into nearby streams. Road building and removal of surface vegetation may also contribute to direct streambed disturbances and sediment influxes. Other influences, however, may be less obvious and much more insidious. One of the principal and most persistent results of mining is acid mine drainage. Both orphaned and currently operated mines may contribute acidic drainage to nearby waters. Acid production can occur in coal deposits by the generation of sulphuric acid or through the action of oxidizing bacteria on pyrite, a common component of the granitic material in which many western ore deposits occur. The consequences of acid drainage are many and they are expressed in a variety of ways. If pH levels are sufficiently low, fish populations may be reduced directly through fish kills or less directly through reduction in the viability of individuals, their gametes, or their progeny. Aquatic invertebrates, an important source of food for many salmonids, may also be affected by acid drainage; they may be directly poisoned or their habitats may be degraded by deposition of ferric hydroxide. In addition, the toxicity of many metallic poisons is increased at low pH levels. Tailings piles and settling ponds also may contribute pollutants. Cyanide, a highly toxic chemical that is often used to recover gold, has sometimes entered streams through failure of settling ponds. Acid drainage through

The Richmond Mine of the Iron Mountain copper deposit contains some of the most acid mine waters ever reported. Values of pH have been measured as low as -3.6, combined metal concentrations as high as 200 g/liter, and sulfate concentrations as high as 760 g/liter. Copious quantities of soluble metal sulfate salts such as melanterite, chalcanthite, coquimbite, rhomboclase, voltaite, copiapite, and halotrichite have been identified, and some of these are forming from negative-pH mine waters. Geochemical calculations show that, under a mine-plugging remediation scenario, these salts would dissolve and the resultant 600,000-m^3 mine pool would have a pH of 1 or less and contain several grams of dissolved metals per liter, much like the current portal effluent water. In the absence of plugging or other at-source control, current weathering rates indicate that the portal effluent will continue for approximately 3,000 years. Other remedial actions have greatly reduced metal loads into downstream drainages and the Sacramento River, primarily by capturing the major acidic discharges and routing them to a lime

This Draft Environmental Baseline Progress Report provides a description of the work conducted for the Northern Dynasty Mines Inc. (NDM) 2004 baseline environmental program. This Pebble Project progress report presents the characterization of the existing conditions related to environmental and social conditions of the project area and their incorporation into the project design and operation. This draft report is presented for agency and stakeholder review and comment, to ensure the approach followed and

This section presents the findings of the 2004 surface-water hydrology study at the Pebble Project mine site. It summarizes data collected in 2004 as part of the baseline study program and evaluates future needs based on data gaps that are noted. Hydrologic data were also collected by Cominco, Ltd., for the Pebble Project for various periods between 1991 and 1993. These data are expected to be integrated into a future

This chapter presents the findings of the hydrogeology study carried out in 2004 for the Pebble Project. The study included installation of background monitoring wells, collection of groundwater samples, and collection of additional information leading to characterization of the groundwater regime in the study area. The work was carried out

This section discusses the groundwater sampling results from the 2004 field season. The data are analyzed to determine spatial (lateral and vertical) variations and variations with time. The data are also compared with surface water-quality criteria to provide a benchmark for water quality. Based on the results of this analysis, requirements for further data are noted. Groundwater samples were collected in September and October 2004. The study results will be included in the environmental baseline document and are expected to be used for both the design and the permit applications for construction, operation, and closure of the proposed mine. The objective of the following discussion is to report the progress of groundwater sampling and analysis and the current understanding of groundwater chemistry.

This report presents the preliminary findings of the 2004 study of metal leaching/acid rock drainage (ML/ARD). The results presented in this report are for:
- Static acid-generation testing of rock core obtained prior to 2004 (including previous drilling by Cominco Alaska),
- Element scans for core collected in 2004 from the Tertiary cover rocks and periphery of the deposit near the eventual pit walls of the mine, and
- Static acid-generation testing of metallurgical waste products and water-chemistry analysis from process flowsheet development.

The report does not include results from leach tests and kinetic geochemical tests which are currently underway. As such, the data obtained provide an early indication of the

The purposes of these terrestrial wildlife and habitats studies were fourfold: to document the baseline (predevelopment) conditions; to assist in project design; to provide the basis for assessing effects of project development and mitigation; and to support permit applications. This progress report describes baseline studies of terrestrial wildlife and habitats in the mine study area and the associated road/port study area for the Pebble Project. Because the distinctive nature of species components (mammals, raptors, etc.), different study areas were used, tailored to each group. These study areas are shown on the respective figures for each species group. In the following discussion, each species component (mammals, raptors, etc.) at each location (mine site or road/port area) is addressed in a separate section (e.g., 9.1 is mammals at the mine site, while 9.6

Understanding the location and types of wetlands and other Waters of the United States, as defined under Section 404 of the Clean Water Act (404), is an important component of planning any development in Alaska. The regulations in 404 require an extensive analysis of development options, in order to determine the range of practicable alternatives for each project component. As such, proponents of large developments must provide mapping of areas in and around their preferred development footprint, as

This section presents the findings of the 2004 fish resources study for the proposed mine area. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that additional data will be collected in 2005. The results presented here should be considered preliminary and are subject to change after additional data have been collected. Objectives of the study were to 1) characterize the distribution and relative abundance of fish resources within and adjacent to the deposit in sufficient detail to provide information for impact assessment and mitigation planning, and 2) acquire predevelopment baseline data for comparison with post-development monitoring.

This section presents the preliminary findings of the 2004 marine wildlife study. This study examined the distribution and abundance of marine wildlife (marine-oriented birds and marine-oriented mammals) during two sampling periods in 2004: summer and late fall/winter. The surveys focused on threatened/endangered species (e.g., Steller's Eiders [*Polysticta stelleri*]), species being considered for listing under the Endangered Species Act (e.g., Kittlitz's Murrelet [*Brachyramphus brevirostris*]), depleted or rare species of marine mammals (e.g., beluga whales [*Delphinapterus leucas*], Steller sea lions

Enclosed is an Application for Water Right submitted jointly by Northern Dynasty Mines Inc. and Northern Dynasty Holdings Inc. The mining claims that constitute the Pebble Project are held either by Northern Dynasty Holdings Inc. or its sister corporation, Northern Dynasty Mines Inc. These two Alaska corporations are submitting this application to secure rights to the supply of water needed for the beneficial mining uses in this application for the Pebble Project northwest of the community of Iliamna. Northern Dynasty Mines Inc. is and will continue to be the entity that will carry out exploration, development and administrative work relating to the Pebble Project, including ingress and egress as necessary to withdraw, impound, divert and transport water of the State of Alaska. Therefore, NDMI and NDHI are referred to, collectively, for the puroses of this application, as "Northern Dynasty Mines Inc." Each of the two entities accepts any and all responsibility and liability arising out of applying for, acquiring and holding the water right associated with this application. Submitted with the application are location maps that further identify the site where water will be taken and beneficially used, as well as the information and documentation required pursuant to 11 AAC 93.040. Also enclosed is a Coastal Project Questionnaire (CPQ). NDMI previously has submitted a CPQ for its 2006 exploration drilling program. We understand that the fee required under Alaska law for this application is to be set by negotiation. With this application, NDMI submits a check in the amount of $900 as a deposit to be applied to the fee that will be negotiated for processing this application. We are prepared to work

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None

None

None

None

A study was made of sockeye salmon lake spawning grounds in Iliamna Lake, Alaska. Physical and biological characteristics of a lake shore and an island spawning area were measured. Bottom composition of the lake shore area was 85 percent material 0.1 to 1.7 millimeters in diameter. Bottom composition of the island area was 96 percent material greater tha 6.7 millimeters in diameter. Intergravel water temperatures in the lake shore area were 1°C to 4°C lower than lake water temperature. Little temperature differences were found in the island area. It was concluded that eggs developing in the lake shore area depend on upwelling ground water for water circulation in redds, while in the island area eggs depend on lake water currents for inter-redd water circulation. Rate of sockeye embryo and alevin development was determined by incubating eggs in the hatchery. Development was described by length measurements and anatomical structures. Fifty percent hatched by 643 degree-days, and yolk sac absorption was

None

None

Stream temperature is an aspect of water quality that affects every aquatic organism. Yet taking that temperature is not as easy as it may seem. Placing a thermometer in a stream and recording the reading are simple enough. The problem is that the result does not represent the entire stream, whose temperatures vary markedly over both time and location. Instead of a single measurement, what is needed is a set of measures that describes a stream's "temperature regime." Even then, the process is complicated. Many factors affect the temperature regime, including climate, riparian or stream bank vegetation, and channel form and structure. The factors with the strongest influence vary from time to time and place to place. What's more, patterns of variation in stream temperature differ depending on the timescale of observation and the size of the area within which temperature is measured. For instance, variation in stream temperature over a single day is apt to differ from variation over an entire year. Similarly, the patterns of temperature observed within a single pool or riffle in a stream are apt to differ completely from the patterns observed along the entire stream course. Stream temperature regimes are difficult to quantify, but available evidence suggests that stream temperature regimes in the Pacific Northwest are now typically different from those that existed before Euro- Americans settled the region. Evidence further shows that a variety of human activities often are responsible for changes in temperature regimes over time and that the effects of human activities often are cumulative: individual land use activities that alone would not substantially alter stream temperature can do so when combined with other activities or with natural disturbances. Alteration of these regimes in turn may

We develop and illustrate the concept of 'hydrologic spiralling' using a high-resolution (2x2m grid cell) simulation of hyporheic hydrology across a 1.7 km^2 section of the sand, gravel and cobble floodplain aquifer of the upper Umatilla River of northeastern Oregon, USA. We parameterized the model using a continuous map of surface water stage derived from LIDAR remote sensing data. Model results reveal the presence of complex spatial patterns of hyporheic exchange across spatial scales. We use simulation results to describe streams as a collection of hierarchically organized, individual flow paths that spiral across ecotones within streams and knit together stream ecosystems. Such a view underscores the importance of: (1) gross hyporheic exchange rates in rivers, (2) the differing ecological roles of short and long hyporheic flow paths, and (3) the downstream movement of water and solutes outside of the stream channel (e.g. in the alluvial aquifer). Hydrologic spirals underscore important limitations of empirical measures of biotic solute uptake from streams and provide a needed hydrologic framework for emerging research foci in stream ecology such as hydrologic connectivity, spatial and

Fishes inhabiting streams and rivers in the interior of North America experience a continental climate. Water temperatures reach 0°C in winter and are high in summer. There is a marked seasonal cycle in discharge. These circumstances make groundwater a crucial component of river habitats. Groundwater can influence the distribution, reproductive success, biomass and productivity, behaviour and movements of fishes, and is especially important in winter and summer. Winter flows are minimal and are affected by ice. In winter, the importance of groundwater increases northwards. Groundwater provides overwintering habitat free of subsurface ice and fish may migrate long distances to take advantage of it. The melt season can account for up to half the annual discharge. In summer, groundwater is important for maintaining discharge and moderating stream temperatures. During critically hot weather, groundwater refugia protect species exposed to temperatures approaching their thermal limits. Since groundwater exerts such an important influence on river habitats, its quality, quantity and sustainability should be considered before development proposals are approved which could alter it. Examples of the role of groundwater in the ecology of some species show how localised and critical habitats influenced by groundwater can be, and, in consequence, how necessary it is to protect them. Protection is complicated because groundwater distribution pathways are often unknown and recharge areas may be remote from discharges. Scale becomes important in identifying potential risks to critical stream habitats from all types of landscape modification and water abstraction.

Few subjects have generated as much emotional dialogue around conflicting scientific and policy agendas as the protection and management of Pacific salmon resources. In this major new work, esteemed fisheries expert Thomas Quinn distils from the vast scientific literature the essential information on the behaviour and ecology of Pacific salmon, including steelhead and cutthroat trout. Unlike other books that examine only selected life stages, habitats, or species, this book - richly illustrated with beautiful photographs and original drawings - thoroughly covers the complete life cycle, emphasizing common themes and differences among the various species of salmon. Representing the range of species and geographic regions, Quinn includes examples from classic studies by pioneers of salmon biology and from the most current research to illustrate the important features of salmon life history and behaviour and the complex physical, biological, and human factors that affect them. "The Behavior and Ecology of Pacific Salmon and Trout" introduces salmon and trout as a group, with a brief description of each species, and compares them to other fishes. This book then follows salmon on their amazing homeward migration from the open ocean, through the complex coastal waters, and upstream to the precise location where they were spawned years earlier. It explains the patterns of mate choice, the competition for nest sites, and the fate of the salmon after their death. It describes the lives of offspring during the months they spend incubating in gravel, growing in fresh water, and migrating out to sea to mature. Quinn emphasizes the importance of salmon to humans and to natural ecosystems and

Predation on Pacific salmon by bears (genus *Ursus* L., 1758) can be an important ecosystem process because the spatial distribution of carcasses largely determines whether marine-derived nutrients cycle through aquatic or terrestrial pathways. Direct observations on three streams in southeastern Alaska indicated that 49% of the pink (*Oncorhynchus gorbuscha* (Walbaum, 1792)) and chum (*Oncorhynchus keta* (Walbaum in Artedi, 1792)) salmon killed by bears were carried into the forest. The tendency of bears to tranport carcasses was independent of the sex and species of salmon, but unspanwed fish were more often transported than fish that had completed spawning. Data on tagged sockeye salmon (*Oncorhynchus nerka* (Walbaum in Artedi, 1792)) in one southwestern Alaska stream indicated that 42.6% of the killed salmon were transported, and that higher percentages were transported in years when salmon densities were greater. At six other streams, on average, 68.1% of the sockeye salmon killed were apparently transported away from the stream into the forest. Combining the data from all
The Suitability Index (SI) curves and graphs and Habitat Suitability Index (HSI) models presented in this report are based primarily on a synthesis of information obtained from a review of the literature concerning the habitat requirements of the species. The HSI models and SI curves are scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat). Assumptions used to transform habitat use information into an index are noted, and guidel ines for appl ication of the curves and model s are described. A discussion of IFIM
Salmonids spawn in highly diverse habitats, exhibit strong genetic population structuring, and can quickly colonize newly created habitats with few founders. Spawning traits often differ among populations, but it is largely unknown if these differences are adaptive or due to genetic drift. To test if sockeye salmon (*Oncorhynchus nerka*) populations are adapted to glacial, beach, and tributary spawning habitats, we examined variation in heritable phenotypic traits associated with spawning in 13 populations of wild sockeye salmon in Lake Clark, Alaska. These populations were commonly founded between 100 and 400 hundred sockeye salmon generations ago and exhibit low genetic divergence at 11 microsatellite loci (F_{ST}\0.024) that is uncorrelated with spawning habitat type. We found that mean P_{ST} (phenotypic divergence among populations) exceeded neutral F_{ST} for most phenotypic traits measured, indicating that phenotypic differences among populations could not be explained by genetic drift alone. Phenotypic divergence among populations was associated with spawning habitat differences, but not with neutral genetic divergence. For example, female body color was lighter and egg color was darker in glacial than non-glacial habitats. This may be due to reduced sexual selection for red spawning color in glacial habitats and an apparent trade-off in carotenoid
A detailed search and re-evaluation of the known historical cases of tailings dam failure was carried out. A corpus of 147 cases of worldwide tailings dam disasters, from which 26 located in Europe, was compiled in a database. This contains six sections, including dam location, its physical and constructive characteristics, actual and putative failure cause, sludge hydrodynamics, socio-economical consequences and environmental impacts. Europe ranks in second place in reported accidents (18%), more than one third of them in dams 10–20 m high. In Europe, the most common cause of failure is related to unusual rain, whereas there is a lack of occurrences associated with seismic liquefaction, which is the second cause of tailings dam breakage elsewhere in the world.

We investigated five a priori hypotheses on factors affecting year-class success of commercially exploited Tanner crabs, Chionoecetes bairdi, in Bristol Bay, Alaska, through correlation analysis and multiple regression modelling. Estimates of recruitment from Zheng et al.'s (1998; Can. Spec. Publ. Fish. Aquat. Sci. 125:97±105) length-based analysis of assessment survey and commercial catch data were used to index year-class strength. This work extends results of an earlier study (Rosenkranz et al., 1998; Alaska Fish. Res. Bull. 5:18±24), which reported positive correlations between Tanner crab year-class size and northeast (NE) winds during the spring larval period, by considering the effects of nondirectional wind speed, bottom and surface water temperature, and abundance of the potential predators sockeye salmon (Oncorhynchus nerka) and Pacific cod (Gadus macrocephalus). No relationships were found between year-class size and mean wind speed or predator abundance, but positive correlations were found with bottom temperatures during gonadal development and egg incubation. Linear regression models with the independent variables NE wind and bottom temperature accounted for about half the variability in the year-class strength index (r-squared=0.50 for males, r-squared=0.48 for females). Anomalously cold bottom temperatures may adversely affect the Tanner crab reproductive cycle, and NE winds may promote coastal upwelling while

Abundance estimates of wild and hatchery Pacific salmon *Oncorhynchus* spp. are important for evaluation of stock status and density-dependent interactions at sea. We assembled available salmon catch and spawning abundance data for both Asia and North America and reconstructed total abundances of pink salmon *O. gorbuscha*, chum salmon *O. keta*, and sockeye salmon *O. nerka* during 1952-2005. Abundance trends were evaluated with respect to species, regional stock groups, and climatic regimes. Wild adult pink salmon were the most numerous salmon species (average = 268 x10^6 fish/year, or 70% of the total abundance of the three species), followed by sockeye salmon (63 x 10^6 fish/year, or 17%) and chum salmon (48 x 10^6 fish/year, or 13%). After the 1976-1977 ocean regime shift, abundances of wild pink salmon and sockeye salmon increased by more than 65% on average, whereas abundance of wild chum salmon was lower in recent decades. Although wild salmon abundances in most regions of North America increased in the late 1970s, abundances in Asia typically did not increase until the 1990s. Annual releases of juvenile salmon from hatcheries increased rapidly during the 1970s and 1980s and reached approximately 4.5 x 10^9 juveniles/year during the 1990s and early 2000s. During 1990-2005, annual production of hatchery-origin adult salmon averaged 78 x 10^6 chum salmon, 54 x 10^6 pink salmon, and 3.2 x 10^6 sockeye salmon, or approximately 62, 13, and 4%, respectively, of the combined total wild and hatchery salmon abundance. The combined abundance of adult wild and hatchery salmon during 1990-2005 averaged 634 x 10^6 salmon/year (498 x 10^6 wild

As part of the National Park Service's Inventory and Monitoring Program, biologists from the US Geological Survey's Alaska Science Center conducted an inventory of birds in montane regions of Katmai and Lake Clark National Parks and Preserves during 2004-2006. We used a stratified random survey design to allocate samples by ecological subsection. To survey for birds, we conducted counts at 468 points across 29, 10-km x 10-km (6.2-mi x 6.2-mi) sample plots in Katmai and 417 points across 25, 10-km x 10-km sample plots in Lake Clark. We detected 92 and 104 species in Katmai and Lake Clark, respectively, including 40 species of conservation concern. We detected three species not previously recorded in Katmai (Ring-necked Duck [i], Lesser Scaup [Aythya affinis], and White-tailed Ptarmigan [Lagopus leucurus]) and two species not previously recorded in Katmai (Northern Flicker [Colaptes auratus] and Olive-sided Flycatcher [Contopus cooperi]). The most commonly detected species in both parks was Golden-crowned Sparrow (Zonotrichia atricapilla); Fox Sparrow (Passerella iliaca) and American Pipit (Anthus rubescens) were abundant and widely-distributed as well. We defined sites as low (100-350 m), middle (351-600 m), or high (601-1620 m) elevation based on the distribution of vegetation cover, and similarly categorized the 34 most-commonly detected species based on the mean elevation of sample points at which they were detected. High elevation (i.e., alpine) sites were characterized by high percent cover of dwarf shrub and bare ground habitat and supported species like Rock Ptarmigan (L. mutus), American Golden-Plover (Pluvialis dominica), Wandering Tattler (Tringa incana), Alaska Peninsula/Becharof National Wildlife Refuge staff conducted a survey of spring staging waterfowl on the Naknek River in the Bristol Bay drainage, Alaska Peninsula, Alaska, from 14 March - 16 May, 2006. Standardized ground surveys have been conducted on the Naknek River since 1992 (surveys were initiated in 1991), and historical information on phenology, species composition, and abundance is presented for each survey year. In 2006, we observed 23 species, including Brant (*Branta bernicla*) for the first time since 2003. Brant and ring-necked duck (*Aythya collaris*) were only seen during disturbance surveys. We analyzed the upper and lower route data separately for first arrival date, peak count, and peak date summaries. Fifteen-year averages of these data were calculated for 13 principal species on the upper route and eight on the lower route. Peak counts were high, and arrival and peak counts were late for many waterfowl species this year. We re-sampled survey data from all years to obtain waterfowl counts

Local, short-term dispersal by the U.S. federally-threatened leopard darter, Percina pantherina, was examined in the field and in the laboratory to assess the possible effects of natural versus man-made barriers on movement. Mark-resight studies were conducted in two summers at sites in the Glover River (southeastern Oklahoma, U.S.A.). At one site, patches of 'preferred' habitat were separated by a natural riffle; at the other site, by a low-water road crossing with culverts. At the natural riffle site, darters moved downstream across the riffle, but also moved upstream into deeper water when water temperatures exceeded 29° C in the 'preferred' habitat. Use of deeper, cooler waters by this species in late summer suggests that thermal refugia may be important habitats for the long-term management of leopard darters. At the Road Crossing site, all documented movement was in a downstream direction, and at least two darters

Northeastern Bristol Bay, Alaska, which includes three large estuaries, is used by multiple sea duck species during the annual cycle. Limited aerial surveys indicate that this area supports tens of thousands of king eiders and black scoters during spring migration and the autumn molt. Existing satellite telemetry data were used to assess the temporal patterns of habitat use and spatial distribution of king eiders and black scoters in northeastern Bristol Bay throughout the annual cycle. King eiders used northeastern Bristol Bay during all months of the annual cycle and black scoters used the area during spring through fall. Both species exhibited a similar seasonal pattern of use that corresponded with the timing of life cycle stages. Abundance of both species was highest during spring migration and the autumn molting period and lowest during summer. Use by king eiders did not occur during all winter months in every year of the study. King eiders were more broadly distributed than black scoters and were located farther from shore in deeper water. Core use areas had minimal overlap, suggesting a degree of spatial segregation between species and a preference for divergent habitats in northeastern Bristol Bay. Further study of potential variation in invertebrate community structure that may correlate with the observed interspecific spatial segregation in habitat

One of the most spectacular phenomena in nature is the annual return of millions of salmon to spawn in their natal streams and lakes along the Pacific coast of North America. The salmon die after spawning, and the nutrients and energy in their bodies, derived almost entirely from marine sources, are deposited in the freshwater ecosystems. This represents a vital input to the ecosystems used as spawning grounds. Salmon-derived nutrients make up a substantial fraction of the plants and animals in aquatic and terrestrial habitats associated with healthy salmon populations. The decline of salmon numbers throughout much of their southern range in North America has prompted concern that the elimination of this "conveyor belt" of nutrients and energy may fundamentally change the productivity of these coastal freshwater and terrestrial ecosystems, and consequently their ability to support wildlife, including salmon. If

For decades ecologists have recognized the potential importance of marine derived nutrients (MDN) deposited in freshwater ecosystems by spawning anadromous salmon. Previous studies have shown that some MDN are retained in freshwater ecosystems. A popular hypothesis linking MDN to salmon population productivity posits that MDN provided by post-spawning mortality of salmon are critical for salmon population dynamics because they enhance prey populations in the freshwater ecosystems used as nursery habitats. We tested this hypothesis by reconstructing historical sockeye salmon populations for the last 300 years in Bristol Bay, Alaska. Stable nitrogen isotope chronologies in lake sediments and sockeye catch and escapement histories show that commercial fisheries intercepted about two-thirds of MDN bound for freshwater spawning grounds since about 1900. Reconstruction of lake algal production using fossil pigments shows that this loss of MDN has reduced lake algal productivity to about one-third of its level before commercial fishing. However, contrary to expectation, recent sockeye population sizes (sum of spawning escapement and fishery catch) in the last century were equivalent to those before the advent of commercial fishing. These data

One of the most pervasive themes in ecology is that biological diversity stabilizes ecosystem processes and the services they provide to society, a concept that has become a common argument for biodiversity conservation. Species-rich communities are thought to produce more temporally stable ecosystem services because of the complementary or independent dynamics among species that perform similar ecosystem functions. Such variance dampening within communities is referred to as a portfolio effect and is analogous to the effects of asset diversity on the stability of financial portfolios. In ecology, these arguments have focused on the effects of species diversity on ecosystem stability but have not considered the importance of biologically relevant diversity within individual species. Current rates of population extirpation are probably at least three orders of magnitude higher than species extinction rates, so there is a pressing need to clarify how population and life history diversity affect the performance of individual species in providing important ecosystem services. Here we use five decades of data from *Oncorhynchus nerka* (sockeye salmon) in Bristol Bay, Alaska, to provide the first quantification of portfolio effects that derive from population and life history diversity in an important and heavily exploited species. Variability in annual Bristol Bay salmon returns is 2.2 times lower than it would be if the system consisted of a single homogenous population rather than the several hundred discrete populations it currently consists of. Furthermore, if it were a single homogeneous population, such increased variability would lead to ten times more frequent fisheries closures. Portfolio effects are

Salmonids are an important component of biodiversity, culture and economy in several regions, particularly the North Pacific Rim. Given this importance, they have been intensively studied for about a century, and the pioneering scientists recognized the critical link between population structure and conservation. Spatial structure is indeed of prime importance for salmon conservation and management. At first glance, the essence of the metapopulation concept, i.e., a population of populations, widely used on other organisms like butterflies, seems to be particularly relevant to salmon, and more generally to anadromous fish. Nevertheless, the concept is rarely used, and barely tested. Here, we present a metapopulation perspective for anadromous fish, assessing in terms of processes rather than of patterns the set of necessary conditions for metapopulation dynamics to exist. Salmon, and particularly sockeye salmon in Alaska, are used as an illustrative case study. A review of life history traits indicates that the three basic conditions are likely to be fulfilled by anadromous salmon: (i) the spawning habitat is discrete and populations are spatially separated by unsuitable habitat; (ii) some asynchrony is present in the dynamics of more or less distant populations and (iii) dispersal links populations because some salmon stray from their natal population. The implications of some peculiarities of salmon life history traits, unusual in classical metapopulations, are also discussed. Deeper understanding of the population structure of anadromous fish will be advanced by future studies on specific topics: (i) criteria must be defined for the delineation of suitable habitats that are based on features of the biotope and not on the presence of fish; (ii) the collection of long-term data and the

A stock assessment of rainbow trout *Oncorhynchus mykiss* was conducted during spring and fall 2004 on the Tazimina River in response to reports by user groups of decreased abundance and reduced fish size. From 22 April to 28 May 2004 a mark-recapture experiment to estimate abundance resulted in an estimate of 950 (SE = 213) rainbow trout in river of which 16% (SE = 2.3%) were sexually mature. Sampled fish ranged from 161 to 612 mm FL with a mean length of 307 mm (SE = 4.10). Between 19 and 27 August 2004 CPUE and length distribution were estimated for comparison with past research conducted during the same time frame. Four hundred fourteen (414) rainbow trout were captured with a CPUE of 3.23 rainbow trout per hour. Length distribution

Collections of stomachs from belukha whales taken by Eskimo subsistence hunters in the Bering and Chukchi Seas have greatly increased the data available on spring and summer foods in those areas. During spring migration in the Chuckchi Sea feeding seems influenced by ice conditions. Spring foods include arctic cod, shrimps and octopus. In coastal areas of the northern Bering and Chukchi Seas, summer foods include saffron cod, sculpins, herring, smelt, capelin, salmon, char, shrimps and octopus. Saffron cod was the primary prey species in Norton Sound and Eschscholtz Bay in June. Other species of fishes are eaten in relation to their seasonal patterns of distribution and abundance. Based on information from coastal residents and the literature, similar foods are used in summer from Bristol Bay to the northeastern Chukchi Sea. In Eschscholtz Bay young belukhas ate smaller saffron cod than older animals and males ate proportionately more sculpins than did females. During autumn and winter months pollock are probably the major prey in the southeastern and southcentral Bering Sea

We studied natality in the Northern Alaska Peninsula (NAP) and Southern Alaska Peninsula (SAP) caribou (Ranger tarandus granti) herds during 1996-1999, and mortality and weights of calves during 1998 and 1999. Natality was lower in the NAP than the SAP primarily because most 3 year-old females did not produce calves in the NAP. Patterns of calf mortality in the NAP and SAP differed from those in Interior Alaska primarily because neonatal (i.e., during the first 2 weeks of life) mortality was relatively low, but mortality continued to be signficant through August in both herds, and aggregate annual mortality was extreme (86%) in the NAP. Predators probably killed more neonatal calves in the SAP, primarily because a wolf den (Canis lupus) was located on the calving area. Despite the relatively high density of brown bears (Ursus arctos) and bald eagles (Haliaeetus leucocephalus), these predators killed surprisingly few calves. Golden eagles (Aquila chrysaetos) were uncommon on the Alaska Peninsula. At least 2

Cominco Alaska Exploration Corporation is investigating possible development of its large Pebble Copper porphyry deposit 20 miles northwest of the community of Iliamna in the Bristol Bay Region. Since development of the project would likely impact wildlife resources, Terra Nord was contracted to conduct a reconaissance level wildlife survey of the project area. The purposes of this report are to: 1) document the results of that survey for Cominco's ongoing assessment process; 2) summarize information on

None

None

We completed a second year of aerial survey observations to monitor Black Scoter (Melanitta nigra) breeding populations in western Alaska tundra wetlands. The stratified survey design was based on analysis of intensive systematic surveys flown 1989-1997. We flew 8 survey days from 12-21 June 2004 and 11 survey days from 13-24 June 2005. For each year and observer, we estimated aerial detection rates with independent double-count observations made approximately every fourth transect. The visibility-corrected estimates of breeding populations after combining all 2004-05 data were 108,100 Black Scoter (standard error SE = 13,300), 198,900 (SE = 28,600) Greater Scaup (Aythya marila), and 42,200 (SE =13,200) Long-tailed Duck (Clangula hyemalis). Compared to the similar surveys flown 15 to 7 years ago, estimated total population size indicated declines with average annual change at -3.1% for Scoter, -5.2% for Scaup, and

We examined the site fidelity of spawning adult sockeye salmon (*Oncorhynchus nerka*) by tagging and releasing fish in the same stream reach (controls) and displacing them among different but nearby sites (c. 50 m away). Three sites - two above a stream junction ('upper' reach and 'pond') and one below ('lower' reach) - allowed us to compare the behavior of salmon in the presence and absence of olfactory cues and habitat similarity. Most controls of both sexes (90%) remained in the immediate vicinity of the tagging and release site. When displaced downstream, where the odors of both the upper reach and the pond were detectable, most salmon returned to their former site (65%). Displaced sockeye were more likely to return to the pond from the lower reach than from the upper one (P = 0.05), consistent with olfactory orientation and the

Salmonid fishes aggregate for breeding at spatially defined, suitable habitats. These aggregations may evolve into discrete populations when precise natal homing leads to reproductive isolation, and local regimes of selection lead to adaptation. Population structure is often defined by persistent differences in selectively neutral genetic markers and in mean values of morphological and life-history traits between locations. This approach is limited by the spatial scale at which traits diverge; low levels of reproductively successful straying, combined with similar selective pressures on life-history traits resulting from similar habitat features and environmental conditions, can significantly reduce the power of these discriminatory methods. We compared data on three life-history traits and polymorphism of DNA microsatellites for evidence of population subdivision among sockeye salmon spawning on spatially discrete but physically similar beaches on islands in Iliamna Lake, Alaska. We found small but significant differences in average body length, body depth and age composition between sites as well as significant interactions between site and year. These interactions, reflecting random variation in growth or recruitment among sites, are a powerful tool for

None

None

The stocks of sockeye salmon, *Oncorhynchus nerka*, in Bristol Bay, Alaska, are produced in the lakes and streams of 10 major river systems, which discharge into the bay over a shoreline distance of 193 km. The establishment of fishing areas, the determination when fishing may be permitted, and the effect of exploiting simultaneously several stocks of sockeye salmon require knowledge of the migratory pattern of the individual stocks comprising the run to Bristol Bay during spawning migration. Various mark-and-recapture experiments and exploratory fishing in the eastern Bering Sea and Bristol Bay provide a picture of the migratory pattern of Bristol Bay sockeye salmon from approximately longitude 170 W to the head of Bristol Bay. The main migration route of all stocks of Bristol Bay sockeye salmon is in the offshore waters of the southern half of the entrance to the bay and in the southern half of the bay itself. All stocks remain in the

Although excessive loading of fine sediments into rivers is well known to degrade salmonid spawning habitat, its effects on rearing juveniles have been unclear. We experimentally manipulated fine bed sediment in a northern California river and examined responses of juvenile salmonids and the food webs supporting them. Increasing concentrations of deposited fine sediment decreased growth and survival of juvenile steelhead trout. These declines were associated with a shift in invertebrates toward burrowing taxa unavailable as prey and with increased steelhead activity and injury at higher levels of fine sediment. The linear relationship between deposited fine sediment and juvenile steelhead growth suggests that there is no threshold below which

The North Pacific Ocean has been of great significance to understanding biogeography and speciation in temperate faunas, including for two species of char (Salmonidae: *Salvelinus)* whose evolutionary relationship has been controversial. We examined the morphology and genetics (microsatellite and mitochondrial DNA) of Arctic char (*Salvelinus alpinus*) and Dolly Varden char (*Salvelinus malma*) in lake systems in western Alaska, the eastern and western Arctic, and south of the Alaskan Peninsula. Morphologically, each lake system contained two forms: one (Arctic char) largely confined to lake habitats and characterized by greater numbers of pyloric caeca, gill rakers, and shallower bodies, and another (Dolly Varden) predominated in adjacent stream habitats and was characterized by fewer pyloric caeca, gill rakers, and deeper bodies. MtDNA partial (550 bp) d-loop sequences of both taxa were interspersed with each other within a single 'Bering' clade and demographic inferences suggested historical gene flow from Dolly Varden to Arctic char had occurred. By contrast, the taxa were strongly differentiated in sympatry across nine microsatellite loci in both lakes. Our

The upper reaches of the Kvichak River system extend into Lake Clark National Park and Preserve. This system is the world's most productive spawning and rearing habitat for sockeye salmon. It contributes about 50 percent of sockeye salmon caught in Bristol Bay, 33 percent of the entire catch in the United States, and 16 percent of the total world catch. Wildlife abounds in and near the park and preserve. The Mulchatna caribou herd, numbering nearly 200,000 and said to be the most stable and healthiest herd in Alaska, grazes and calves along the western boundary of the park and preserve. Dall sheep and moose forage the area, and brown and black bear, wolves, lynx, foxes, and other mammals are present. Fish include five species of salmon, rainbow trout, Dolly Varen, lake trout, northern pike, and Arctic grayling. On the Cook Inlet side of the park and preserve, swans and other waterfowl nest on marshes and outwash plains and rocky cliffs in and adjacent to the park provide rookeries for puffins, cormorants, kittiwakes, and other seabirds. Seals and whales may be seen occassionally offshore. The park and preserve contains significant cultural resources since the area has been occupied since prehistoric times. Dena'ina Indians lived at Kijik on Lake Clark until the early 1900s, when they moved to Nondalton and other sites. Other prehistoric sites are located near Lake Telquana and along the upper Mulchatna River. Russian explorers, fur traders, and missionaries began traversing the region in the 1790s. The salmon
This Conservation Plan for the Pacific Walrus in Alaska has been approved by the US Fish and Wildlife Service. During the 1988 reauthorization of the Marine Mammal Protection Act, Congress suggested conservation plans: (1) be prepared where they could benefit the population, and (2) provide certain background material and develop a strategy for achieving the primary goal of the MMPA of maintaining population stocks with their optimum sustainable population level. This plan has been developed accordingly. The Conservation Plan does not necessarily represent official positions or approval by cooperating agencies or organizations. The Conservation Plan was prepared by the staff, Marine Mammals Management, US Fish and Wildlife Service with the assistance of the Marine Mammal Commission, the Eskimo Walrus Commission, and the University of Alaska to delineate reasonable actions believed required to conserve the Pacific walrus population within the requirements of the Marine Mammal Protection Act of 1972, as amended. While many of the contributions and recommendations made by these organizations have been incorporated into this Plan, the Plan does not necessarily represent the views of these groups, nor does it always represent a consensus of these views. This Conservation Plan will be reviewed on a periodic basis
None
None
None
None
None
None

The five naturally occurring and one transplanted caribou (*Ranger tarandus granti*) herd in southwestern Alaska composed about 20% of Alaska's caribou population in 2001. All five of the naturally occurring herds fluctuated considerably in size between the late 1800s and 2001 and for some herds the data provide and indication of long-term periodic (40-50 year) fluctuations. At the present time, the Unimak (UCH) and Southern Alaska Peninsula (SAP) are recovering from population declines, the Northern Alaska Peninusal Herd (NAP) appears to be nearing the end of a protracted decline, and the Mulchatna Herd (MCH) appears to now be declining after 20 years of rapid growth. The remaining naturally occurring herd (Kilbuck) has virtually disappeared. Nutrition had a significant effect on the size of 4-month-old and 10-month-old calves in the NAP and Nushagak Peninsula Herd (NPCH) and probably also on population growth in at least four (SAP, NAP, NPCH, and MCH) of the six caribou herds in southwestern Alaska. Predation does not appear to be sufficient to keep caribou herds in southwestern Alaska from expanding, probably because rabies is endemic in red foxes (*Vulpes vulpes*) and is periodically transferred to wolves (*Canis lupus*) and other canids. However, we found evidence that pneumonia and hoof rot may result in significant mortality of caribou in southwestern Alaska, whereas there is no evidence that disease is important in the dynamics of Interior herds. Cooperative conservation programs, such as the Kilbuck

This report summarizes the results of a preliminary investigation of caribou use of the proposed Pebble Copper mine site, northwest of Iliamna Lake, Alaska between April 1992 and December 1993. The Mulchatna Caribou Herd (MCH) has been expanding in range and number for the past decade and it is estimated to contain at least 82,000 animals. Seasonal ranges of the MCH include the proposed Pebble Copper mine site and associated road corridors near Iliamna Lake. Some caribou remain in the vicinity of the proposed mine throughout the year, not migrating north and west with the rest of the herd in the spring and summer. In recent years, most of the MCH shifted its winter range to concentrate on areas west from Iliamna Lake. Calving areas for the MCH are in the vicinity of the upper Mulchatna River and near the headwaters of the Koktuli River. The Koktuli River calving area is immediately adjacent to the proposed mine site. Up to 18% of the caribou harvested from the MCH are reportedly taken from areas near the

This report summarizes the results of capture and survey activities on caribou radio-collared near the proposed Pebble Copper mine site, northwest of Iliamna Lake, Alaska between April 1992 and December 1993. The Mulchatna Caribou Herd (MCH) continued to expand in range and number during this investigation and was estimated to include from 110,000 to 130,000 animals. Caribou that were radio-collared near the mine site appeared to be representative of the entire MCH. Seasonal ranges included the proposed Pebble Copper mine site and associated road corridors near Iliamna Lake. In the late 1980's, most of the MCH shifted its winter range to concentrate on areas west from Iliamna Lake. Calving areas were in the vicinity of the upper Mulchatna River, Mosquito River, and Harris Creek, as well as portions of Kaskanak Creek southwest of the proposed mine. Ridges between the Nushagak and Kuskokwim drainages were favored in the summer and fall. Some caribou remained in the vicinity of the proposed mine throughout the year, not migrating north and west with the rest of the herd in the spring and summer. Large mammal observations near the mine site were also noted

The Alaska National Interest Lands Conservation Act (ANILCA; P.L. [Public Law] 96-487) of 1980 mandated that rural Alaskans be given priority use of fish and wildlife on federal public lands for subsistence purposes. This concept conflicts with the Alaska Constitution, which guarantees equal access to resources to all users. The resulting conflict spawned a dual state/federal management system and considerable controversy. In southwestern Alaska, this dilemma is exacerbated by the equally dominant cultures of indigenous Yup'ik Eskimos and more recent immigrants from western cultures. Although wildlife conservation is an important goal of both cultures, management philosophies and practices are dissimilar and sometimes contradictory. This is especially true for brown bears (*Ursus arctos*), which hold an important place in Yup'ik culture and are highly prized by trophy hunters. In 1991 and 1992, brown bear subsistence hunting seasons were significantly liberalized in southwest Alaska. In recognition of the potential danger of this liberalization, the state and federal regulatory boards concurrently stipulated a research program to determine bear density and harvestable surplus in a representative portion of the area. We began the investigation in 1993, but have been hampered by conflicts between Yup'ik and western beliefs. Nevertheless, we have gained important insights into dynamics of the bear population and attained a better appreciation for Yup'ik traditions. Our null hypothesis was that bear density could withstand increased harvest pressure associated with liberalized hunting seasons. We

From headwaters to mouth, the physical variables within a river system present a continuous gradient of physical conditions. This gradient should elicit a series of responses within the constituent populations resulting in a continuum of biotic adjustments and consistent patterns of loading, transport, utilization, and storage of organic matter along the length of a river. Based on the energy equilibrium theory of fluvial geomorphologists, we hypothesize that the structural and functional characteristics of stream communities are adapted to conform to the most probable position or mean state of the physical system. We reason that producer and consumer communities characteristic of a given river reach become established in harmony with the dynamic physical conditions of the channel. In natural stream systems, biological communities can be characterized as forming a temporal continuum of synchronized species replacements. This continuous replacement functions to distribute the utilization of energy inputs over time. Thus, the biological system moves towards a balance between a tendency for efficient use of energy inputs through resource partitioning (food, substrate, etc.) and an opposing tendency for a uniform rate of energy processing throughout the year. We theorize that biological communities developed in natural streams assume processing strategies involving minimum energy loss. Downstream communities are fashioned to capitalize on upstream processing inefficiencies. Both the

The dynamic and hierarchical nature of lotic ecosystems may be conceptualized in a four-dimensional framework. Upstream-downstream interactions constitute the longitudinal dimension. The lateral dimension includes interactions between the channel and riparian/floodplain systems. Significant interactions also occur between the channel and contiguous groundwater, the vertical dimension. The fourth dimension, time, provides the temporal scale. Lotic ecosystems have developed in response to dynamic patterns and processes occurring along these four dimensions. An holistic approach that employs a spatio-temporal framework, and that perceives disturbances as forces disrupting major

1. This review is presented as a broad synthesis of riverine landscape diversity, beginning with an account of the variety of landscape elements contained within river corridors. Landscape dynamics within river corridors are then examined in the context of landscape evolution, ecological succession and turnover rates of landscape elements. This is followed by an overview of the role of connectivity and ends with a riverine landscape perspective of biodiversity. 2. River corridors in the natural state are characterised by a diverse array of landscape elements, including surface waters (a gradient of lotic and lentic waterbodies), the fluvial stygoscape (alluvial aquifers), riparian systems (alluvial forests, marshes, meadows) and geomorphic features (bars and islands, ridges and swales, levees and terraces, fans and deltas, fringing floodplains, wood debris deposits and channel networks). 3. Fluvial action (erosion, transport, deposition) is the predominant agent of landscape evolution and also constitutes the natural disturbance regime primarily responsible for sustaining a high level of landscape diversity in river corridors. Although individual landscape features may exhibit high turnover, largely as a function of the interactions between fluvial dynamics and successional phenomena, their relative abundance in the river corridor tends to remain constant over ecological time. 4. Hydrological connectivity, the exchange of matter, energy and biota via the aqueous medium, plays a major though poorly understood role in sustaining riverine landscape diversity. Rigorous investigations of connectivity in diverse river systems should provide considerable insight into landscape-level functional processes. 5. The species pool in riverine landscapes is derived from terrestrial and

We used mark–recapture techniques to examine the effects of four types of road crossings on fish movement during spring base flows and summer low flows in small streams of the Ouachita Mountains, west-central Arkansas. We assessed movement for 21 fish species in seven families through culvert, slab, open-box, and ford crossings and through natural reaches. We detected no seasonal or directional bias in fish movement through any crossing type or the natural reaches. Overall fish movement was an order of magnitude lower through culverts than through other crossings or natural reaches, except no movement was detected through the slab crossing. In contrast, open-box and ford crossings showed little difference from natural reaches in overall movement of fishes. Numbers of species that traversed crossings and movement within three of four dominant fish families (Centrarchidae, Cyprinidae, and Fundulidae) also were reduced at culverts relative to ford and open-box crossings and natural reaches. In spring, retention of fishes was consistently highest in stream segments upstream of crossings and lowest in downstream segments for all crossing types, a response attributed to scouring associated with spring spates. Water velocity at crossings was inversely related to fish

Total dissolves solids (TDS) are naturally present in water or are the result of mining or some industrial treatment of water. TDS contain minerals and organic molecules that provide benefits such as nutrients or contaminants such as toxic metals and organic pollutants. Current regulations require the periodic monitoring of TDS, which is a measurement of inorganic salts, organic matter and other dissolved materials in water. Measurements of TDS do not differentiate among ions. The amount of TDS in a water sample is measured by filtering the sample through a 2.0 µm pore size filter, evaporating the remaining filtrate and then drying what is left to a constant weight at 180°C. The concentration and composition of TDS in natural waters is determined by the geology of the drainage, atmospheric precipitation and the water balance (evaporation-precipitation). The mean salinity of the world's rivers is approximately 120 mg/L and the major anion found in natural waters is bicarbonate. The most commonly occurring cation in fresh water is calcium. Changes in TDS concentrations in natural waters often result from industrial effluent, changes to the water balance (by limiting inflow, by increased water use or increased precipitation), or by salt-water intrusion. It is recommended that

The subsistence harvest survey in Bristol Bay has been conducted for eight years: 1995, 1997, 1999, 2000, 2001, 2002, 2004, and 2005. On the Togiak National Wildlife Refuge (Refuge), the survey has been conducted for ten years, 1995-2005. (No survey was conducted in Bristol Bay in 2003). Summary tables of Bristol Bay bird and egg harvests from 1995-2005 are included here. Summary tables of harvests for each sub-region: Togiak, Nushagak-Dillingham-Iliamna (including King Salmon-Naknek), and Alaska Peninsula, 2001-2005, are also included (Tables 1-6). Detailed harvest tables are included for each species, with estimates by survey period and sub-region, from 1995 through 2005 (Tables D-1 D44). The subsistence harvest survey in Bristol Bay includes

Pacific herring (*Clupea pallasi*) eggs were collected from spawning grounds in Bristol Bay, Alaska, transferred to Norway for hatching, and for 63 days raised in a 2000-m^3 marine basin located at the Flodevigen Biological Station. The eggs were from the same spawning, and hatching took place over 3 days. Upon completion of hatching, 24,840 larvae (12.42 larvae/m^3) were released into the basin. Larval growth was rapid and metamorphosis was observed 28 days after hatching at a length of 25 mm. The experiment was terminated by draining the basin; 4891 juveniles were recovered. The average rate of growth was 0.66 mm/day in length and 2.89 mg/day in weight. The larval length frequency, unimodal at hatching, segregated into three modes within 2 weeks, which persisted until termination. The slowest growth rate was 0.31 mm/day and the larger herring averaged 1.48 mm/day. At first feeding, copepod nauplii were abundant but food declined later. Cannibalism was observed on day 45 and a 30-mm herring was
The salmon spawning ground report is compiled annually to report the results of spawning ground surveys conducted by the Division of Commercial Fisheries staff in Bristol Bay. The report describes the conditions under which salmon were observed and other factors affecting escapement data. Although data have been collected for more than 20 years in most cases, appendix tables contain only information from the last 20
In February 2006, the US Supreme Court heard cases that may affect whether intermittent streams are jurisdictional waters under the Clean Water Act. In June 2006, however, the cases were remanded to the circuit court, leaving the status of intermittent streams uncertain once again. The presence of commercial species, such as coho salmon (*Oncorhynchus kisutch*), can be an important consideration when determining jurisdiction. These salmon spawn in the upper portions of Oregon coastal stream networks, where intermittent streams are common. In our study of a coastal Oregon watershed, we found that intermittent streams were an important source of coho salmon smolts. Residual pools in intermittent streams provided a means by which juvenile coho could survive during dry periods; smolts that overwintered in intermittent streams were larger than those from perennial streams. Movement of juvenile coho into intermittent tributaries from the mainstem was another way in which the fish exploited the habitat and
Data on tundra swans (*Cygnus columbianus columbianus*) were obtained on the northern Alaska Peninsula from 1983 to 1987. Phenology was advanced 2-4 weeks of swan nesting areas in the Subarctic and Arctic, but a late spring retarded nesting by at least ten days. The highest densities of potential breeders (0.3-0.9 swans□km^{-2}) occurred along the lowland coast and in broad drainage basins. Estimates of the breeding population ranged from 4000 to 4600 swans. Brood sizes in August ranged from 2.7 ± 0.3 SE to 3.3 ± 0.5 young. In summer, 51-66% of the adults and subadults were observed as potential breeders, and the remainder were in nonbreeding flocks.
Many wildlife species feed on anadromous fishes of several life-history stages. There is evidence for some wildlife species that the availability of anadromous fish is critically important for survival or reporduction. In some regions anadromous fishes in fresh water appear to be keystone food resources for vertebrate predators and scavengers, forging an ecologically significant link between aquatic and terrestrial ecosystems. The spatial distribution of anadromous fish in fresh water, including the occurrence of runs in very small streams, has important consequences for wildlife biology (social interactions,
(From Introduction): Anadromous and inshore-spawning marine fish provide a rich, seasonal food resource that directly affects the biology of both aquatic and terrestrial consumers and indirectly affects the entire food web that knits the water and land together. In addition, the authors suggest that the presence of a seasonally abundant food resource has helped to shape the evolution of aquatic and terrestrial consumers and that predators have proabably exerted reciprocal evolutionary pressures on their prey, potentially influencing the life history and morphology of these fishines. Finally, the authors suggest that anadromous and inshore-spawning fishes constitute such an important prey base for terrestrial wildlife that conventional ecology dogmas need to be revised. Interactions between anadromous fishes and wildlife have been recognized as having some general ecological importance (e.g., Brown 1982), but only recently have the ramifcations of these interactions and their potential magnitude begun to be

A spatially intensive survey in 1989 of 52 sites in the Red River drainage in southwest Oklahoma and surveys in all years from 1978 to 1987 on four sites in the drainage provided evidence that construction of Altus Dam on the North Fork of the Red River caused major changes in fish community structure in the river above the dam. Pre-impoundment data on the fish communities were scanty, but the inferences they allowed were similar to those obtained by comparing fish assemblages in the North Fork above the dam with assemblages elsewhere in the drainage, particularly along Salt Fork, which had similar habitat characteristics. Twenty-five species were collected in the North Fork above Altus Dam, compared to 33 in the Salt Fork and 34 in the North Fork below the dam. The speckled chub *Macrhybopsis* (formerly *Hybopsis*) *aestivalis* and the chub shiner *Notropis potteri* were absent in the North Fork above Altus Dam but fairly common in similar streams elsewhere in the area. The plains minnow *Hybognathus placitus* and the Red River shiner *Notropis bairdi* were among the most common fish species found in southwest Oklahoma, but were not collected above Altus Dam in the 1989 survey and were collected only intermittently and in small numbers in the long-term survey. We speculate that these two species have repeatedly been extirpated and have been reestablished as bait-bucket introductions since the dam was closed. Upstream of the reservoir, the sand shiner *Notropis stramineus* and the emerald shiner *Notropis*

Lake Iliamna, a freshwater lake located 362 km (225 mi) southwest of Anchorage, is home to a small breeding colony of harbor seals (*Phoca vitulina*). Iliamna is the largest lake in Alaska, measuring 124 km (77 mi) long and 35 km (22 mi) wide. These seals are known to live in the lake year round. Although the lake is connected to the Bristol Bay via the Kvichak River 120 km (75 mi) in length, there are no known accounts of immigration or emigration. The only other instance of a freshwater population of harbor seals is the subspecies (*P. v. mellonae*) that inhabits Lacs des Loups Marins on the Ungave Peninsula of northern Quebec, Canada. Worldwide, there are only four other lake dwelling seals (all believed to be, or descended from, ringed seals). They inhabit the freshwater Lake Baikal (*P. sibirica*); Lake Saimaa (*P. hispida saimensis*); Lake Ladoga (*P. h. ladogensis*) and the saltwater (1.2%) Caspian Sea (*P. caspica*). In a continuing effort to monitor harbor seal abundance, distribution, and trend throughout Alaska, scientists from NOAA's National Marine Mammal Laboratory (NMML) flew six surveys of Lake Iliamna in July and August 2008. These surveys occurred at different times of day and varying weather conditions to understand how covariates such as date, time of day, and weather, influence seal haul-out. The counts, unadjusted for covariates, indicated that there were at least 235 seals at the lake during the survey period. This compares with counts of 137 in 1991 (Mathisen and Kline, 1992); 321 in 1998 (Small, 2001); 225 in 1999 (Small, 2001); and 102 in 2005 (NMML, unpublished data). Iliamna

The South Fork basin of the Coeur d'Alene River, Idaho, has been an area of heavy mining activity since the 1880s. The mining operations have resulted in elevated concentrations of metals in surface water, most notably cadmium, lead, zinc, and, to a lesser extent, copper. The metals affected surface water quality downstream in the Coeur d'Alene basin and are suspected to be one of the primary reasons for the reduction in populations of native westslope cutthroat trout Oncorhynchus clarki lewisi. The avoidance response of a surrogate species, Snake River cutthroat trout O. clarki (unnamed subspecies), was evaluated against conditions simulating those in the Coeur d'Alene River basin. Cutthroat trout avoided a metals mixture of these concentrations: Cd (0.30 μg/L), Cu (6.0 μg/L), Pb (0.6 μg/L), and Zn (28 μg/L). The avoidance response to either Cu or Zn alone was similar to the avoidance response to the mixture, suggesting that avoidance to the mixture was due to these metals. After acclimation to Zn at 55 μg/L for 90 d, cutthroat trout detected and preferred a lower Zn concentration of 28 μg/L. The lowest Zn concentrations avoided (28 μg/L) were 1/6 to 1/78 the Zn

Recent declines in the number of sockeye salmon returning to Lake Clark caused economic hardship in the region and raised resource concerns among local subsistence users and Federal managers. This final report describes findings from a two year study with two primary objectives: 1) to identify sockeye salmon spawning areas using radio telemetry, and 2) to describe genetic variation within and divergence among spawning populations. Radio Telemetry Research: A lack of information regarding spawning habitat distribution in Lake Clark instigated this study. To determine spawning distributions, 332 adult sockeye salmon were radio tagged as they entered Lake Clark in 2000 and 2001. Fish were relocated every 5-10 days by boat, plane, or remote solar powered receiver. On average, a radio tagged fish was relocated 12.7 times (range, 3 - 33) and over 3,500 relocations were made. Thirty-five spawning areas were identified, including three sites downstream of the tagging area and five sites identified by visual observation or seining. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Spawning habitat locations were mapped into the Geographic Information System for Lake Clark National Park and Preserve. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; most of which were adjacent to an obvious clear water source. About 75% of identified spawning habitats are adjacent to privately owned lands, many slated for development. Proactive measures should be taken to conserve these habitats. Genetics Research: Prior to this study genetic information was lacking for Lake Clark originating sockeye salmon populations. Molecular genetic markers provide managers with more precise tools with which to identify and manage fish populations. Small clips of fin tissue (non-lethal) were obtained from 1,442 sockeye salmon representing 13 Lake Clark and 2 northeastern Lake Iliamna spawning populations in 2000 and 2001. Allele frequencies differed significantly across 11 microsatellite loci in 94 of 105 pair-wise population comparisons. Pairwise estimates of F_{ST} ranged from 0 to 0.089. There is significant genetic divergence between populations of Lake Clark and Sixmile Lake, the latter being more similar to fish of Lake Iliamna. The reduced numbers of alleles and strong divergence of most Lake Clark

Although humpback whitefish are the second most important subsistence fish species harvested in the Kvichak River watershed, few data are available to assist managers in evaluating a reported recent decline in this species' abundance. Initial research on humpback whitefish in Lake Clark National Park began in 2005, and indicates they are both attracted to and derive nutrients from anadromous sockeye salmon. Our growth equations (Figure 8) indicate rapid growth until age 4 - 7, which is likely when individuals become sexually mature which would slow growth rates. The lack of individuals of intermediate sizes could be due to differences in year class strength, selection by the subsistence fishery, or predators. After fish reach a size of ≥380 mm, predation likely declines and mortality in the population may stabilize at a low level for the rest of the life span. The lack of a strong Sr spike in the 10 otoliths analyzed for anadromy suggests Lake Clark whitefish either remain in freshwater throughout their life, or that they use

Combined stream survey data for 2008 - 2010 indicated salmon presence in 3 of every 4 headwater streams of less than 10% gradient draining to an anadromous river, including streams on top of the Pebble Prospect. Rearing salmon were documented above dry stream reaches and in waters disconnected from rivers suggesting salmon access such sites during annual floods or via subsurface groundwater channels. Non-salmon species important to subsistence, such as Dolly Varden char, were found in 96% of streams surveyed. A total of 168 km (104.3 miles) of previously undocumented salmon streams, were nominated for the first time to the State's Anadromous Water Catalog. The State accepted all 2008 and 2009 new salmon stream nominations, available at (http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm) and 2010 nominations are currently under review. Aerial survey data verified adult salmon presence in an additional 358 km (253 miles) of streams and rivers that needed confirming data. This study

Environmental impacts of acid mine drainage (AMD) from Dexing Copper Mine, the largest open pit copper mine in Asia, on Le An River were well documented 10 years ago. However, ore production of the mine has increased fourfold and the contamination situation of the river now is unknown. Our studies indicated that heavy metal concentrations in riverwaters (dissolved), suspended solids (SS) and sediments all showed highly localized distribution patterns closely associated with two AMD-contaminated tributaries (Dawu River and Ji River) and are significantly different from the previous findings. Compared with the previous reports, most of the sampling sites in Le An River displayed lower contents of sediments of 2005 because several historical upstream and downstream heavy metal sources disappeared or became unimportant.
This report describes findings from a sockeye salmon *Oncorhynchus nerka* radio telemetry and spawning habitat study conducted in the Lake Clark watershed in 2000 and 2001. The primary objectives of this research were 1) to locate and map all major spawning aggregations 2) to determine basic characteristics of spawning habitats, and 3) to determine the distribution of private land uses and subsistence/sport use locations in relation to salmon spawning habitats. Thirty-five spawning areas were identified. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; however, the timing of spawning activity in turbid habitats coincided with a dramatic decrease in the concentration of suspended sediment and turbidity. Water quality parameters were all within acceptable range for freshwater aquatic life. Subsistence fishing for migrating sockeye salmon occurs throughout Lake Clark near seasonal and year-round residences. Residents of Nondalton harvest red fish (spawning sockeye salmon) from spawning areas. Sport harvest occurs at the outlet of Lake Clark, the outlet
None
The scope of this report is limited to assessment and analysis of chemical reactions related to drilling and seismic surveys that have the potential to impact water resources. In general, contamination of surface water may occur through: fuel spills from drills and water pumps, surface discharge of drilling fluids, breakdown products of drilling chemicals, chemical reactions with drill cuttings, and ammonia from seismic charges. Contamination of groundwater may occur through: introduction of grout, clay, fuel, and drilling additives into holes and wells; improper closure of drill holes, particularly in
None
None

None

Annotation	404(c) Categories Muncipal water supplies	Shellfish beds	Fishery areas
The wolf management report for northern Bristol Bay (pp. 118-125) indicates wolves are common throughout the region, though historic and current abundance remains undocumented. The Nushagak and Mulchatna drainages support the highest densities in the area. Trapper reports and other observations suggest a stable population during the reporting period. Wolf population estimates are provided based on trapper questionnaires, incidental observations during moose and caribou surveys, and harvest			
The brown bear management report for northern Bristol Bay is on pages 175 - 186. Brown bears are described as common throughout the area, and particularly abundant along salmon spawning areas in the Nushagak, Mulchatna, Togiak, and Kulukak drainages as well as throughout the Wood River/Tikchik Lakes. Hunting in the region has increased since the mid 1990s, and pressure is highest along the Nushagak River and Mulchatna River drainages and in the mountains surrounding the Wood River/Tikchik Lakes. Nonresidents account for the majority of brown bear harvest. Human activities in villages in the area frequently attract brown bears including open landfills, residential garbage, dog food, and fish-drying racks. Habitat in the region is described as virtually unaltered and in excellent condition. The report indicates proposed development of the Pebble copper and gold mine has the possibility of			
The caribou management reports for Bristol Bay (Mulchatna caribou herd) and the northern Alaska Peninsula (Northern Alaska Peninsula caribou herd) are on pages 14-42. They describe the historical abundance of both herds based on observations and aerial surveys. The Mulchatna herd probably peaked in abundance in 1996 at 200,000 animals. The 2006 estimate was 45,000 animals. Range increased and changed after herd size peaked from the north and west side of Iliamna Lake to the Kuskokwim River for wintering. Calving areas have changed as well, from the upper reaches of the Mulchatna River and the Bonanza Hills to the Mosquito River and Harris Creek drainages north of Koliganek. A possible reason for the changing range is an exceedance of carrying capacity in former wintering areas, and extensive trampling and grazing in summer areas. Population size and harvest statistics are listed for both herds. The Northern Alaska Peninsula caribou herd (NPACH) is currently in decline, of concern to ADFG. Population counts ranged from 15,000 to 19,000. The herd winters between the Naknek and Alagnak Rivers. The NPACH has been designated a			
The purpose of the study was to obtain current estimates of the economic contribution of sportfishing activities to the Alaska economy and develop a consistent method for producing such estimates on a regular basis. Sportfishing is important to Alaska's economy and culture. The vast majority of sportfishing takes place in the Southcentral region of Alaska, which includes Bristol Bay. $989 million were spent in 2007 in the Southcentral region, 11,535 jobs were supported by the industry, and $91 million were generated in state and local taxes. Expenditures are analyzed. About half of			Yes
The furbearer management report for the Bristol Bay Region is on pages 197-217. It describes trapping as an important part of the culture and economy of the residents of the region, and a primary source of income prior to the growth of the commercial fishing industry. Beaver were historically the most important furbearer in the area, but beaver trapping effort dropped as commercial salmon prices rose. Other furbearers commonly trapped in the region include red fox and land otter. Lynx, wolverines, marten, mink, and coyotes are also trapped, though less commonly. Beaver, otter, red fox, and wolverine populations are reported as stable. Lynx populations are reported as low. No data were available to assess coyote, marten, mink, or weasel population trends.			
A map depicting water bodies in the USGS Naknek quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from:			Yes

The black bear management report for Bristol Bay may be found on pages 199-207 of this report. Little is known about black bears in the region, though the greatest densities are suspected to occur in the upper Mulchatna and Nushagak rivers along the Chichitnok River. Nonresidents account for the majority of reported black bear harvest. Black bear habitat in the region is described as virtually unaltered and in excellent condition. Harvest statistics are listed at the end of the report. Similar documents			
The moose management report for the Bristol Bay region may be found on pages 246-268. It describes moose as relatively new inhabitants to the region, with increasing populations during the last three decades. It indicates moose are common along the Nushagak/Mulchatna rivers and all of their major tributaries as well as the Wood-Tikchik lakes area. Population trends have been increasing dramatically in recent years despite increased predation by wolves and bears and higher harvest levels. Harvest statistics are listed at the end of the report. Similar documents produced in previous years may			
A map depicting water bodies in the USGS Dillingham quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from:			Yes
A map depicting water bodies in the USGS Iliamna quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from:			Yes
A map depicting water bodies in the USGS Lake Clark quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from:			Yes
A table with sport fish harvest in southcentral Alaska (including Bristol Bay) listed by species for salmon, resident fish, as well as smelt, halibut, shark, rockfish, lingcod, Pacific cod, razor clams, and other fish. May be obtained from the ADFG website:		Yes	Yes
ADFG news release describing the 2010 Bristol Bay Salmon season. The run was estimated at 40.19 million fish, with a preliminary catch estimate of 29 million sockeye ranking 17th and 11th, respectively, since statehood. The inshore run was 6% above the annual 20-year average (1990-2009) of 37.97 million, and 1% higher than forecasted. The Naknek-Kvichak District harvested 10.66 million fish, 28% higher than forecast, while the Nushagak District harvested 8.3 million sockeye making it the second largest harvest in the history of that district. Other salmon harvest numbers are included for Bristol Bay: 31,400 Chinook, 1.09 million chum, 104,000 coho, and 1.34 million pink salmon for an overall harvest of approximately 31 million fish. The ex-vessel value of the 2010 fishery is calculated as $153,115,042. Additional details regarding allocation			Yes
This document includes 40 maps outlining land designations and habitat areas in Bristol Bay for marine invertebrate gathering, waterfowl trapping, salmon, freshwater fish, marine mammals, caribou, geese, shorebirds, gulls and terns, eagles, Stellar's eiders, brown bears, and swans for each community.		Yes	Yes
This document describes lure restrictions for rainbow trout and lists catch-and-release and fly-fishing only areas in Southwest Alaska. It includes a map detailing fishing restrictions.			Yes

None	Yes		Yes
Pages 34-39 contain information specific to Western Alaska's shorebirds, listing priority shorebird species that commonly breed, stage during migration, or winter in the area (Table 5). The region overall hosts over 30 species of breeding shorebirds. Priority conservation issues and actions are outlined, as are threats from climate change, and shorebird hunting and collecting. This document and previous versions may be obtained from the following website: http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.			
None			

None			Yes
None			Yes
None			Yes

The article documents distribution and relative numbers of 32 species of pelagic birds observed in Bristol Bay: eight Arctic loons and three additional loons, fulmars, shearwaters, storm petrels, cormorants, ducks (including Harlequin ducks), eiders, scoters, turnstones, sandpipers, phalaropes, gulls, terns, and alcids (including marbled murrelets and puffins). Distribution maps based on transect surveys are included in the article.			
None			Yes
None			Yes

None			
Addresses the impacts of roads to salmonid rivers in headwater streams.			Yes
The article highlights the importance of habitat diversity of Bristol Bay sockeye salmon to local adaptation.			Yes
None			Yes
A dichotomous taxonomic key to fishes of the Kvichak including 22 known species captured by seining, gill netting, trawling, angling, tow netting, and rotenoning.			Yes
None			
Walrus foraging marks are mapped indicating high, medium, and low use areas of Bristol Bay by walrus.			

The report concludes that brown bears extensively use the salmon streams of the area, and that the hills around the ore body are used as some of the only denning habitat along the northwest side of Iliamna Lake. Harvest data indicate that hunters use the area around the proposed mine to hunt bears. Moose surveys indicate low densities in the vicinity of the proposed mine, although harvest data indicate substantial moose hunting effort. Trapping data indicate that the area around the proposed mine is particularly popular for beaver, lynx, otter, wolf, and wolverine harvest.			
This report is one of very few that provide baseline habitat data in the Bristol Bay drainage area. Kijik Lake is outside of the area that would be directly impacted by mineral development, though the spawning salmon populations migrate through the project area to reach spawning beds in Kijik lake.	Yes		Yes
The website summarizes marine mammal research conducted by the Bristol Bay Native Association. It documents beluga whale movement in both the Nushagak and Kvichak Rivers as well as Bristol Bay on several sampling occasions in 2008 and 2009. Walrus subsistence harvest guidelines are outlined for Bristol Bay. A harvest monitoring program is described. Additional information can be found at the following website:			
The report documents sockeye and coho salmon as well as rainbow trout, Dolly Varden, Arctic grayling, threespine and ninespine stickleback, northern pike and slimy sculpin in Upper Talarik Creek, the South Fork Koktuli River, and the North Fork Koktuli River in the vicinity of the copper deposit. Chinook salmon and burbot are also documented in the South Fork Koktuli River, and Chinook, chum, least cisco and humpback whitefish are documented in the North Fork Koktuli River. Only resident fish species are documented in the Chulitna River drainage, including Dolly Varden, Arctic grayling, pygmy whitefish, longnose sucker, ninespine stickleback, and slimy sculpin. Slimy sculpin were the most abundant and widely distributed fish species in the region, followed by Dolly Varden. Spawning sockeye and their carcasses are documented in Upper Talarik Creek downstream of the North Fork confluence in general agreement with the State of Alaska's Anadromous Waters Catalog (AWC). Coho were found throughout the Upper Talarik and North Fork Koktuli River, in extension of their distribution shown in the AWC at that time, and the author states that 'it is strongly			Yes

None			Yes
None			Yes
None			Yes

None			
None			Yes
The Alagnak River in the Kvichak drainage is generally accessed by floatplanes from King Salmon or area lodges. This report documents the number of anglers in both boats and rafts on four reaches of the river from June through August. Angling was most common in the lower river, with as many as 110 anglers per day.			Yes

The National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring Program report provide the most comprehensive small mammal data for the region. The area may be directly impected in the future as state mineral claims extend into the Chulitna River watershed which drains to Lake Clark. Many of the species inventoried in this report have ranges which may extend into the area.			
None			Yes
The basic features of stream ecosystem structure and various functional ecological components and their interrelationships are defined for some representative streams. The article focuses on two general functions of running waters: the efficient conversion of organic matter, especially particulates, to CO_2 and the maintenance of a minor role played by in-stream plant growth. The article ends with a plea to incorporate the 'new stream ecology' into management strategies directed at freshwater resources,			Yes
None			
None			Yes

None			Yes
Stellar's Eiders are listed as threatened under provisions of the US Endangered Species Act. The article indicates that Stellar's eiders occur in Alaska near headlands and in estuaries from Nunivak Island and the Yukon-Kuskokwim Delta to the southern Alaska Peninsula in the State of Alaska (including Bristol Bay).			
Maps of survey sites and tables documenting waterbird and mammal observations are appended to the report. Earlier versions of this report may be obtained from the USFWS website: http://alaska.fws.gov/mbsp/mbm/reports.htm.			
None			
None			
Describes the water source for Clark's Point as spring-fed wells. Water is treated with chlorine and flouride. Commercial fishing forms the economic base for the community. Fish and salmon subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes		Yes

Describes the water source for Dillingham as three deep wells. Water is treated and piped to 40% of the community. The remaining 60% use individual wells. Commercial fishing, fish processing and storage, and other support for the fishing industry forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local	Yes		Yes
Describes water sources of individuals as wells, or surface water from a nearby unnamed lake. Ekuk was formerly home to a fish packing company. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes		Yes
Describes the water source for Ekwok as primarily individual wells. Fish and wildlife subsistence activities are crucial to the livelihood of residents as most residents are not interested in participating in a cash economy. A handful of residents fish commercially, and the village corporation owns a fishing lodge. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be	Yes		Yes
Describes the water source for Igiugig as the Kvichak River due to inadequate groundwater supplies. Should mining commence, the risk of drinking water contamination of the Kvichak River exists. Residents depend on the commercial salmon fishery as well as fish and wildlife subsistence activities. Trophy rainbow trout attract sport fishermen to the area, and seven commercial lodges operate in Igiugig, serving sport fishermen and hunters. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with	Yes		Yes
Describes water sources for Iliamna as individual wells. Commercial fishing, sport fishing and tourism are listed as major sources of income for the community. Subsistence hunting and fishing is also an important source of livelihood for the community. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices,	Yes		Yes
Describes water sources for King Salmon as primarily shallow individual wells, and a small community well for FAA housing. Commercial fishing is important to the King Salmon Economy, as is tourism given its proximity to Katmai National Park and Preserve. Sportfishing is also popular in the area. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be	Yes		Yes
Describes water sources for Kokhanok as a piped water system as well as a separate well and treatment facility for the local school. Commercial fishing is an important, if declining economic base in the community. Most residents rely heavily on fish and wildlife subsistence. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website:	Yes		Yes
Describes water source for Levelock as individual wells. Commercial fishing, fish processing, and storage form the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes		Yes
Describes Naknek's water source as primarily individual wells. Commercial fishing and processing are central to the economy of the village. Government is another source of employment in the village. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA	Yes		Yes
Describes water source for New Stuyahok as treated community well water. The salmon fishery forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes		Yes

Describes water sources for Newhalen as treated water derived from a community well. Commercial fishing and sport fishing for trophy rainbow trout provide economic opportunities in Newhalen. Residents also depend on fish and wildlife to support their subsistence lifestyle. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local	Yes		Yes
Describes water sources for Nondalton as treated surface water from Six-Mile Lake. Commercial fishing and subsistence hunting are primary sources of livelihood in the village. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website:	Yes		Yes
Describes water sources for Pedro Bay as individual wells or surface water from Iliamna Lake. Employment consists largely of commercial fishing and tourism services. Subsistence hunting and fishing is also an important source of livelihood. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes		Yes
Describes water sources for Port Alsworth as individual wells or hauled water from nearby surface water sources. The economic base of Port Alsworth relies on lodges and outfitters/guides for summer recreation, as well as limited commercial fishing. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes		Yes
Describes water sources for Portage Creek as hauled from downriver (Portage Creek). Residents depend on fish and wildlife subsistence activities, and a lodge operates during the summer. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website:	Yes		Yes
Describes South Naknek's water source as primarily individual wells (surface or groundwater are not indicated), and some piped water. Commercial fishing and processing are central to the economy of the village, and residents depend on subsistence hunting and fishing. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from	Yes		Yes
None			Yes

The study was conducted in the Pedro Pond complex, a group of ponds connected to the east end of Iliamna Lake near the village of Pedro Bay.			Yes
None			
None			Yes
The article reviews data on mining waste generated from active and inactive mining sites in the western U.S. The review revealed that in nine states over 2,500 miles of surface waterways were impacted by AMD. Of this total area, approximately 85 percent was attributed to copper, iron ore, uranium, and phosphate mining activities. Approximately one-half of the waste generated was mining rock waste and one-third was tailings, with the balance consisting of dump/heap leaching wastes and mine water.			

Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.			Yes
None			Yes
None			Yes
The paper describes the Kvichak River system as the largest producer of sockeye salmon in Alaska, as well as the history of the Bristol Bay fishing industry and the sockeye runs. Population dynamics of the fishery are modeled, and management alternatives are discussed based on the results.			Yes

The article describes the Yukon-Kuskokwim Delta and the Bristol Bay Lowlands as the two most important breeding areas for greater white-fronted geese in the Pacific Flyway. The work was stimulated by population declines of those geese. It includes a map documenting autumn migration and wintering areas.			
None			
None			
None			

The Alaska Fishery Research Bulletin may be obtained at the following website: http://www.adfg.state.ak.us/pubs/afrb/afrbhome.php.			Yes
The report includes a map of areas used by Manokotak hunters to harvest moose and marine mammals, and documents edible weight of subsistence for Manokotak and Dillingham at 2006 and 715 pounds, respectively. Mean household harvest is documented for 19 Bristol Bay communities for salmon, other fish, marine invertebrates (butter and razor clams), land mammals, marine mammals, furbearers, birds and eggs, and plants. Response to growing hunting pressure by recreational hunters is discussed.		Yes	Yes
Similar reports for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.			Yes

This report briefly describes the subsistence fisheries of the Bristol Bay Management Area, with a primary focus on the salmon fisheries. It is based on information gathered through the department's subsistence salmon permit system and from research conducted by the Division of Subsistence. The population, communities and cash economy of the region are described. General harvests in Bristol Bay are described as amongst the largest in the state and include salmon (51% of the harvest), land mammals (mostly moose and caribou, 31%), non-salmon fish (10%), and other resources such as marine mammals, birds and eggs, marine invertebrates, and wild plants (8%). The average annual value of the average household subsistence in the region is estimated at $7,195 overall, and $11,420 in village households in a region with average annual income of $13,154. Subsistence regulations are described and subsistence permit use is characterized. Results indicate subsistence salmon harvest has declined more than half in the last two decades, primarily in the Nushagak and Naknek/Kvichak districts as the result of lower average catches rather than less participation by residents. Declines are attributed to poor returns and scarcities of			Yes
Bristol Bay subsistence is described in pages 63-74. Regulations are discussed, and subsistence harvests are estimated at 124,679 fish for 2007, the majority of which were sockeye salmon (80%). Subsistence harvest is broken down by region. Subsistence for non-salmon fish are also described, including halibut, Alaska blackfish, burbot, Arctic grayling, Arctic char, Dolly Varden, lake trout, longnose suckers, rainbow smelt, rainbow/steelhead trout, herring, northern pike, and whitefish. Similar reports for previous years can be obtained from the ADFG website:			Yes
Analysis for Port Alsworth, Nondalton, Iliamna, and Newhalen. Kvichak River sockeye salmon comprise the largest subsistence harvest in Bristol Bay, but are listed as a "stock of management concern" due to the stock's chronic inability to meet escapement goals. The study indicates that poor returns were a factor responsible for steadily declining harvest since the 1960s. Declining returns are of great concern to residents. Subsistence harvest between the four communities has ranged from about 30,000 to nearly 90,000 sockeye salmon since 1963, comprising from 44% to 89% of the total subsistence harvest. The report includes maps of subsistence fish camps and harvest locations on Iliamna Lake, Sixmile Lake, Lake Clark, and the Newhalen River. Fishing and processing is described and illustrated. Kinship relations between subsistence fishers as well as distribution of fish about the village are described using case studies. Winter fishing and non-salmon fishing are also discussed briefly. Declining populations of caribou and moose are discussed as an explanation for higher harvest goals for salmon in recent years. Increased fuel costs are a major concern in the region and also may increase subsistence harvest goals as the cost of shipping store-bought foods increases accordingly. Cultural and social values of subsistence are explored. The authors conclude subsistence fishers have developed fishing and processing practices			Yes
None			Yes

None			
None			
The report describes the high-seas distribution, migrations and identification of major stocks of sockeye salmon together with the relationship of distribution to the environment. A brief discussion of the life history of sockeye salmon and of the spawning stocks is provided as background information. The report concludes with a section detailing the distribution and hypothetical models of migration of stocks of sockeye salmon of Asia and North America. Page 4 includes a map representing locations of important sockeye salmon river systems and average annual commercial catch of sockeye salmon in important coast and high seas fishing areas, 1961-1971.			Yes
The report describes property and ownership of the Pebble Copper-Gold-Molybedenum Project, as well as site geology and exploration. Exploration drilling is described in the area, and mineral resource estimates are provided as: 5.94 billion tonnes of 'Measured and Indicated Mineral Resources' grading 0.78% CuEQ, containing 55 billion pounds of copper, 67 million ounces of gold, and 3.3 billion pounds of molybdenum; and 4.84 billion tonnes of Inferred Mineral Resrouces grading 0.53% CuEQ, containing 25.6			

In light of the crisis of salmon declines in the Pacific Northwest and the billions of dollars spent unsuccessfully to restore them, the authors review the growing body of literature examining the importance of salmon derived nutrient subsidies to both freshwater and riparian communities. The Bristol Bay region is used to illustrate the magnitude of nutrients imported from the ocean, as much as 5.4×10^7 kg of Nitrogen, 2.7×10^5 kg of Ca, plus other macroelements for a run of 20 million sockeye. Those nutrients disperse as far upstream in freshwater as suitable habitat is accessible, extending the interface between ocean and land. A multitude of species interact with and benefit from those nutrients including bears, insects, birds, benthos, zooplankton, and riparian vegetation. Salmon-derived nutrients increase lake productivity, macroinvertebrate growth, and juvenile salmon growth thereby increasing their survival. Birds associated with riparian habitat are found in greater densities on salmon streams. The carrying capacity of bears increases vastly where salmon are available. Fitness-related variables, including growth rates, litter sizes, and reproductive success, have been attributed to salmon availability for salmon consumers such as eagles, bears, and mustelids, highlighting the importance of salmon to their population dynamics. Management implications of reviewed research is discussed and the authors point out that artificially placing			Yes
None			
The report documents tagging undertaken in 1922 to determine spawning grounds of the important sockeye salmon fishery in what was known at the time as the Alaska Peninsula Fisheries Reservation. Sockeye tagged and released at Unga Island, of the Sumagin Island Group, and Port Moller are documented for the first time returning to			Yes
Wolverine harvest density is high in the Bristol Bay region relative to much of Alaska as indicated in Figure 3.			
None			Yes

The article includes figures and data regarding salmon-derived nitrogen in nursery lakes in Bristol Bay dating back to A.D. 1700 as well as annual catch of western Alaska sockeye salmon.			Yes
None			Yes
A preeminent text on Pacific salmon ecology.			Yes
Population for Bristol Bay loons are as follows: 1,998 (±520) red-throated loons (*G. stellata*), 1,275 (±281) Pacific loons (*G. pacifica*), and 920 (±289) common loons (*G. immer*). Relative abundance of loons among production areas in Alaska are presented in Figure 2, and population trends from 1972 through 1992 are presented in Figure 3.			

None			Yes
Southwest Alaska and the Arctic-Yukon-Kuskokwim Delta are considered together for the purposes of this report, which provides a profile of sport anglers, the economic significance of sport fishing, and the net economic value to the state. It lists Bristol Bay's Naknek River as Alaska's 9th most popular sport fishing site.			Yes
None			

None			
None			Yes
None			Yes

Lake Iliamna seals are referred to as one of only two populations of harbor seals in the world that reside solely in freshwater without exploiting the marine environment. It indicates that they exhibit no regular movement up or down the river.			Yes
Descriptions of the mineral occurrences in the Iliamna quadrangle as part of a statewide Alaska database on mines, prospects and mineral occurrences throughout Alaska.			
None			
None			Yes
The author hypothesizes that the good biological track record for Bristol Bay arises from four factors: (1) a clear objective of maximum sustainable yield; (2) the escapement-goal system, which assures maintenance of the biological productive capacity; (3) management by a single agency with clear objectives and direct line responsibility; and (4) good luck in the form of lack of habitat loss and good ocean conditions since the late 1970s. Catch and spawner-recruit data are presented for the area, as are landed values for some of the fisheries. The author hypothesizes that the economic failure of the Bristol Bay fishery is due to the converse of the factors leading to biological success:			Yes

None			Yes
Although the study area would not be directly impacted by mine development, a great deal of tundra ponds, similar in nature exist close to the proposed development.			Yes
Distribution of the Mulchatna, Nushagak Peninsula, and Northern Alaska Peninsula caribou herds are illustrated in Figure 1. Population dynamics of the Mulchatna caribou herd are discussed, indicating that in 1996, the herd was the second largest in Alaska at 200,000 animals. Range changes of the herd are mapped in Figure 2. Caribou were reintroduced to the Nushagak Peninsula in 1988 and their population quickly expanded to over 1000 animals.			

This article has implications for fisheries in that the species analyzed serve as important forage items for fish. Climate change may reduce forage densities and size.			Yes
Subsistence hunting for caribou, moose, bears, and sheep are described as extremely common in 18 Bristol Bay communities where surveys were conducted. 41% of households hunted moose, and 37% hunted caribou, and the vast majority of all households used moose and caribou (73.4% and 81.1%, respectively). Harvest and use of bears and Dall sheep is relatively low. Harvest of large mammals in usable pounds ranged from 16 pounds per person in Port Alsworth to 369 pounds per person in Nondalton in 2001/2002. Harvest data is presented by species and community.			
None			

None			
None			Yes
This paper explores the reason the earth supports so many kinds of organisms. It focuses attention on problems of species diversity and community organization that have occupied many theoretical and empirical ecologists before and since it was written. It concludes that taxa containing many diversified species will 'evolve' more readily than undiversified taxa, with limits imposed by brain size and 'niche' space; the evolution of biological communities produces complex inter-relationships which increase the stability of the community as a whole; and that smaller organisms exhibit greater diversity than large ones, and thus the evolutionary processes are different for smaller organisms than			Yes
The article arguably serves as the basis of freshwater biogeochemistry. It is one of the first to discuss streams not as isolated systems, but strongly linked to the valleys that they drain in complex chemical and biological relationships. It describes the influence of valley geology as well as vegetation on inorganic chemistry of streams. It discusses the importance of water source, valley slope, soil permeability, and terrestrial vegetation transpiration to streamflow, referred to as a prime ecological factor in streams. It further describes organic inputs driving water chemistry and stream foodwebs and freshwater			Yes
Between 1975 and 2008, the Commercial Fisheries Entry Commision (CFEC) issued 1,875 drift gillnet and 1,041 set gillnet permits. Permits held by local Alaskans has dropped while permits to nonlocal Alaskans and nonresidents has increased due to permit transfer, permit holder relocation, and permit cancellation. Earnings are presented and range from a total of $10,529,539 in 1975 to $186,085,765 in 1990 for the drift gillnet fishery and $1,039,384 in 1975 to $26,789,265 in 1988 for the gillnet			Yes

Addresses the impacts of roads to salmonid systems including extirpation of salmon resulting from low genetic diversity caused by roads crossing salmonid streams.			Yes
Describes diving behavior of Pacific walrsus in Bristol Bay including foraging for bivalve molluscs in the region.		Yes	
None			

Sport fishing participation is broken out by regions in tables at the end of the report. Bristol Bay is included in southcentral Alaska for the purposes of this report.		Yes	Yes
This catalog is a numerically-ordered list of the water bodies in the Southwest Region of Alaska with documented use by anadromous fish. An associated Atlas to the Catalog of Water Important for Spawning shows cartographically the location, name and number of each water body, the anadromous fish species documented using them, and the fish life history phases for which the water bodies were documented being used by salmon. Water bodies documented receive statutory protection under sections of AS 16.05.871, which requires persons or governmental agencies to submit plans and specifications to ADFG and receive written approval in the form of a Fish Habitat Permit prior to the proposed use, construction or activities that would take place in specified water bodies.			Yes
None			
None			Yes

This article is frequently cited with regard to fish avoidance of culverts installed as part of road construction.			Yes
None		Yes	Yes
None			Yes
The report describes wide fluctuations of Bristol Bay sockeye salmon ex-vessel prices since 1975 and salmon harvests. It indicates that that the Bristol Bay salmon fishery accounted for 13% of the world salmon supply in 1980 (including wild and farmed salmon) and 2% of the world salmon supply by 2001. The fishery's value exceeded $200 million in twelve of seventeen years analyzed. Processing and marketing of Bristol Bay salmon is also described. It may be viewed at the following website: www.iser.uaa.alaska.edu/iser/people/knapp.			Yes

This application was withdrawn after its submission. It was submitted when the copper-gold-molydenum resource was estimated at about one-fifth the size of the current estimate.			
This application was withdrawn after its submission. It was submitted when the copper-gold-molydenum resource was estimated at about one-fifth the size of the current estimate.			
The text covers needs and values for sustainable fisheries, current Pacific salmon stock status, existing management of Pacific salmon, habitat assessment, artificial (hatchery and net pen) production, modeling approaches to management, habitat protection and restoration, and recommendations for sustainable management.			Yes

The report presents results of research estimating subsistence harvest of three wildlife species by residents of twelve communities of the northern Alaska Peninsula (Naknek, South Naknek, King Salmon, Egegik, Pilot Point, Ugashik, Port Heiden, Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) in mid-1995 through mid-1997. Data were collected by interviewing residents. Harvest estimates included 2173 caribou (mostly from the Northern Alaska Peninsula Herd), 179 moose, and 26 brown bears. Information is provided on the timing and sex of the harvests, as well as harvest locations. Comments summarizing resident interviews note a scarcity of caribou attributed by hunters to changes in migration patterns as well as competition with nonlocal hunters for caribou and moose. Most interviews indicated subsistence harvest needs were met, with a few important exceptions. Broad harvest patterns are discussed. The report concludes that large land mammal resources provide substantial quantities of food to the region's households, and additionally support fundamental			
The report indicates that all households in Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, Pedro Bay, and Port Alsworth used freshwater fish, as did 94.4% of households in Nondalton. Rainbow trout made up the largest portion of the total nonsalmon freshwater fish harvest (30.9%), followed by Dolly Varden (26.9%), northern pike (9.9%), lake trout (8.1%), Arctic grayling (7.1%), whitefish (8.3%), suckers (4.9%), rainbow smelt (3.6%), burbot (0.4%), and black fish (<0.01%). Gear used and timing of harvest is evaluated, and harvests are compared to other years. Traditional ecological knowledge interviews describe popular fishing sites for each species exploited. The study documents the continued importance of subsistence harvests of nonsalmon freshwater fish in the communities of the Kvichak River watershed of the Bristol Bay area. Additional studies for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php			Yes
This study reviews the history and accuracy of water quality predictions for major hardrock mines in the United States by comparing actual water quality to the predictions made in Environmental Impact Statements (EISs) and subsequently identifying common causes of water quality impact and prediction failures. In addition, an analysis was conducted to determine if there were inherent risk factors at mines that may predispose an operation to having water quality problems. Of mines analyzed, 76% had mining-related water quality exceedances in surface or groundwater. Eighty-nine percent of mines with acid drainage predicted low acid drainage potential prior to development. Conclusions are provided about the effectiveness of the underlying scientific and engineering principles used to make water quality predictions in EISs. Finally, recommendations are made for regulatory, scientific and engineering approaches that would improve the reliability of water quality predictions at hardrock mine sites. The document may be downloaded at the following website: http://www.mineralpolicy.org/publications_welcome.cfm. For the mines in their study that developed acid drainage, almost all either underestimated or ignored the potential for acid drainage in their EISs. In terms of predicted (post-mitigation) surface water	Yes		Yes

The majority of world population of Stellar's eiders (a species listed as threatened under the US Endangered Species Act) migrates along the Bristol Bay coast of the Alaska Peninsula in the spring, and crosses the Bay. It is found in and near lagoons and shoals rich in benthic invertebrate prey. Maps of King eider flock distribution are presented in Figures 2 through 8. A list of other species observed during the surveys is included at the end of the document.		Yes	
None			Yes

Although the guide focuses on national parks around Bristol Bay as opposed to areas which would be directly impacted by development, it is some of the only data available regarding shellfish beds for the region. Species assemblages in Bristol Bay presumably resemble some of those described herein.		Yes	
The chapter discusses landscape, climate, fishing conditions, access, services, costs, as well as fishing highlights for the southwest region. It describes fishing location, access, facilities, highlights, and main species for the following southwest Alaska waterbodies: Lake Iliamna, Kvichak River, Newhalen River, Talarik Creek, Copper River (in the eastern Lake Iliamna drainage), Gibralter River, Lake Clark, Tazimina River, Naknek Lake and River, Brooks River, Alagnak River system, American Creek, Coville-Grosvenor Lakes, Lower Nushagak River, Upper Nushagak, Mulchatna River, Chilikradotna River, Koktuli River, Stuyahok River, Nuyakuk River, Wood-Tikchik Lakes, Tikchik River, Kulukak River, Togiak River system, Becharof Lake system, Ugahsik			Yes
From the summary: The article indicates that a biotic community cannot clearly be differentiated from its abiotic environment, referring to the sum total as an 'ecosystem.' Organisms within an ecosystem are grouped into a series of discrete trophic levels, categorized as producers, primary consumers, secondary consumers, etc., each of which is successively dependent upon the preceding level as a source of energy. Producers, however, are directly dependent on solar radiation for energy. The more remote an organism is from solar radiation, the less probability it will be dependent solely upon the preceding trophic level. Quantitative relationships between trophic levels are discussed. The percentage loss of energy due to respiration is progressively greater for higher levels in the food cycle. Consumers at higher trophic levels are progressively more efficient in the use of their food supply. Productivity and efficiency			Yes

None			
None			Yes
None			Yes
This memorandum documents juvenile sockeye rearing in Frying Pan Lake on the South Fork Koktuli as well as juvenile coho above the lake. Juvenile chum salmon are also documented in the drainage.			Yes
Describes habitat requirements for coho salmon including information regarding flow, velocity, substrate, dissolved oxygen, temperature, and other requirements.			Yes
The report concludes for the first time that Bristol Bay and Alaska have an extremely valuable resource in freshwater fish stocks. It indicates that there are suitable commercial stocks of at least Arctic char (6,553 pounds harvested) and whitefish			Yes

The report describes recreational fishing harvest from 1977 through 1997 for southwest Alaska including the Kvichak and Nushagak Rivers, the former of which is described as the world's largest producer of sockeye salmon and the latter is described as the greatest producer of Chinook, chum, coho and pink salmon in Bristol Bay. Smelt dominate the recreational harvest, likely as a result of their abundance, while sockeye, Chinook, and coho salmon are the most frequently harvested species. Dolly Varden/char, rainbow trout, and arctic grayling are taken to a lesser extent. And lake trout, chum, salmon, Northern pike, whitefish, and burbot are harvested at relatively low levels. The value of the region's recreational fishery was estimated at $50 million for 1988. The report also discusses ongoing and complete research and management studies for the region. Management, angler effort, recreational harvest, and outlooks are documented for drainages in southwest Alaska for Chinook, coho, sockeye, rainbow			Yes
None			
Similar reports for previous years' analyses can be found on the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.			Yes

None			Yes
The Chignik River drains to the east coast of the Alaska Peninsula. The article documents 64 bird species in the drainage which expanded the documented range of			
This article does not relate directly to Bristol Bay, but highlights the decline of salmon populations throughout the Pacific Northwest of the United States.			Yes
None			Yes

None			
None			Yes
None			
None			
Results are provided for specific conductance, pH, water temperature, dissolved oxygen, alkalinity and hardness, nutrients, major ions and dissolved solids, total and dissolved trace elements, and low level mercury. Samples were collected from surface and groundwater in the immediate vicinity of the deposit, as well as the area proposed at the time for the road corridor and port facility. Groundwater is characterized around the deposit by low dissolved solids, near neutral pH, average temperature of 4°C, and high dissolved oxygen with few exceptions. Surface water quality around the deposit generally met water quality standards for aquatic-life criteria with the exception of aluminum and alkalinity. The only noted exceedance to water quality standards in groundwater along the road corridor was the pH value from the Newhalen municipal well which was over the criteria of pH 8.5 during both sampling events. Turbidity values also exceeded state water quality samples, though results were not considered reliable. Aluminum standards were exceeded in most sites sampled, and the authors state site	Yes		Yes
Indicates the area surroudning the deposit possesses low buffering capacity and high potential for acid mine drainage.			

The report documents 9,993 caribou in 2004, ten brown bears, four moose, nine wolves, and one wolverine during transect surveys. Nine raptor species and common ravens were recorded in the study area, five of which were confirmed nesting. Twenty-five species of waterbirds were observed, with ducks as the most abundant group. Forty-six bird species were documented, 13 of which are considered conservation priority species, and ten of which were documented nesting in the study area. Along the proposed road corridor, 44 brown bears, one black bear, 14 moose, one coyote, and eight river otters were recorded. Harbor seals were documented repeatedly in Iniskin Bay of Lake Iliamna. Swans, geese, loons, gulls, shorebirds, mergansers, and ducks were observed along the proposed road corridor and in the proposed port area.			
None			
The study documents winter fish presence at 39 sample sites in the three tributaries that would be directly impacted by development, all of which contained sections of flowing water during winter months. Salmonids were documented in all three drainages. Spawning surveys were conducted in spring for Arctic grayling and rainbow trout, and in summer and fall for salmon. Fish populations were estimated for Frying Pan Lake using mark-recapture techniques, fish tissue and index monitoring (water quality and quantity, fish, periphyton, macroinvertebrates, and sediment) were conducted at 16 stream and two lake sites. Flow-habitat study sites were established, aquatic habitat was surveyed and mapped, fish abundance sampling was conducted as was qualitative abundance sampling. Along the road corridor, 120 streams were surveyed for fish, and tissue was collected, though results are not presented. Macroinvertebrate sampling in the entire study area yielded 139 taxa, higher than what has been encountered in other mine development baseline monitoring efforts in Alaska; periphyton samples were collected			Yes
Breeding birds documented in the area included tufted puffins, pigeon guilllemots, pelagic cormorants, horned puffins, glacous-winged gulls, double-crested cormorants, and bald eagles. Researchers also recorded high densities of Harlequin ducks, which previously were proposed for listing as a threatened/endangered species. Mammals recorded consisted mainly of harbor seals. Marine habitat was also evaluated using sediment and infauna sampling.			
None			

None			
None			
Describes places important to area residents and users, as well as critical habitat to key plant and animal resources identified through local ecological knowledge. The information was combined with state and federal agency data to create maps. Probable threats to the watershed are identified as commercial development, community development, recreational subdivisions, mining, roads, and global climate change. The plan outlines the following four strategic actions to address those threats: adequate flow reservations in the Nushagak River; vegetation maintenance to support fish, wildlife,			Yes
This study researched the basic workings of stream ecosystems and factors controlling individual, population, and community productivity in a reach of the Silver Spring River in Florida which is heavily influenced by groundwater. Odum characterized the 'biomass pyramid,' measuring ecosystem metabolism by calculating primary productivity, community productivity, and community respiration. He documented a strong positive correlation between visible light and gross primary production, and concluded that Florida's springs have complex and highly adapted ecologies that have maximized the			Yes

Pages A-64 - A-109 describe impact of non-harvest human activites to salmon fisheries including mining, road building, dam building, water withdrawal, sedimentation, etc. The report states that mining in waters, riparian areas, or flood plains of streams containing or influencing salmon spawning and rearing habitats should be avoided.			Yes
An updated report estimating the Pebble deposit mineral resources comprise: 5.94 billion tonnes of 'Measured and Indicated Mineral Resources' grading 0.78% CuEQ, containing 5 billion pounds of copper, 67 million ounces of gold and 3.3 billion pounds of molybdenum; and 4.84 billion tonnes of 'Inferred Mineral Resources' grading 0.53% CuEQ, containing 25.6 billion pounds of copper, 40.4 million ounces of gold and 2.3 billion pounds of molybdenum, based on data derived from 509 drill holes in total. At the time of this release, depsit estimates increased 17% in resources within higher			
None			Yes
The authors used satellite transmitters to document sandhill crane summer and winter movements. Seven transmitters were deployed on Bristol Bay cranes. Figures 1 and 2 present mapped results of migration activity of all cranes tagged.			
The article argues that the natural flow regime of water plays a critical role in sustaining native biodiversity and ecosystem integrity in rivers. It discusses the effects of river exploitation, river management, and development policies. The authors underline the importance of natural streamflow variability in ecosystems and ecological responses to			Yes
The article discusses the importance of tributary and groundwater temperatures and interconnection in maintaining water temperatures critical to salmonid growth.			Yes

None			
None			Yes
This book is a preeminent text on Pacific salmon ecology. It reviews literature from throughout the Pacific Rim, with several articles focusing on research conducted in Alaska's Bristol Bay.			Yes

None			Yes
Describes habitat requirements for Chinook salmon including information regarding flow, velocity, substrate, dissolved oxygen, temperature, and other requirements. The relationship between flow regime and the quality of salmonid riverine habitat is described.			
The article provides evidence for local adaptation of Lake Clark sockeye salmon to glacially turbid spawning streams, such that intensity of visual signals are reduced while weapon size (e.g., snout length and body size) is increased. It concludes that the presence of a glacial ecotype of sockeye salmon suggests that the excellent colonizing ability of the species may be due in part to an ability to adapt quickly to highly unstable, geologically young habitats.			Yes
The article provided a detailed search and re-evaluation of the known historical cases of tailings dam failures world-wide. Their review of the dam failure databases (i.e., International Commission on Large Dams [ICOLD], U.S. Commission on Large Dams [USCOLD], USEPA and UN Environmental Program) revealed that 147 cases of world-wide tailings dam disasters have occurred. In Europe, the most prevalent of the 15 different failure causes was associated with unusually high rain events. They also noted that failures attributed to weather events (including rainfall, hurricanes, rapid snowmelt and ice accumulation in tailings dam) may also be associated with overflow/overtopping, seepage, foundation failure or bad impoundment management. Outside of Europe,			

Tanner crabs are described as an economically important pot fishery target.		Yes	
Figure 6 indicates that Bristol Bay (Central AK in the figure) supports the world's strongest sockeye salmon run.			Yes
The National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring Program report provides the most comprehensive data for the region. Although Lake Clark National Park and Preserve is not an area that would be directly impacted by proposed mineral development, many of the species inventoried in this report have ranges which may extend into the project area.			

None			
Highlights the risk factors to fish migration of culverts associated with road construction			
None			
None			Yes

None			Yes
None			Yes
Bristol Bay is described as largely pristine with only minimal habitat degradation, unaffected by agriculture, logging or dam building, no hatcheries and sustainable fisheries. The paper concludes: Metapopulation dynamics are, by definition, processes occurring on relatively large scales, often much larger that the territory covered by the jurisdiction of a specific management agency. This is particularly true for anadromous fish species because the series of biotopes they need for their different life stages are spread over large areas of land and ocean.			Yes

The study concludes that the rainbow trout population may be rebounding from depressed levels, and indicates the population is relatively protected due to catch-and-release regulations for sport fishers and the limitation of subsistence fishers to rod-and-reel fishing only. It suggests avenues for further study.			Yes
None			Yes
The Northern Alaska Peninsula (NAP) caribou herd is described as important to local subsistence hunters for centuries and to guides and recreational hunters since the 1950s. Its range is described as the Alaska Peninsula from Nakenek to Port Moller (Figure 1). It reached a peak population size of 20,000 during the early 1980s, but experienced significant declines in the mid-1990s. This study was initiated to understand factors in that decline.			
The study discusses population status, hunting, management objectives and field observations for the mine area itself as well as for the project area at large for the following species: caribou, black bear, brown bear, moose, wolves, furbearers, marine mammals, swans, other waterfowl, seabirds, eagles, and specific threatened and endangered species (which the report lists only as peregrine falcons). It suggest that potential threats from the project may result not only from development itself, but also to			
This report presents the results of a detailed assessment contracted by the Alaska Department of Fish and Game to measure the economic contribution that sportfishing made to the state of Alaska and its regional economies in 2007. The most angler spending in the state occurred in the Southcentral region including Bristol Bay, at 72%. In 2007, 475,534 resident and nonresident licensed anglers fished 2.5 million days in Alaska and spent nearly $1.4 billion on licenses and stamps, trip-related expenditures, pre-purchased packages, and equipment and real estate used for fishing. The $1.4 billion of angler spending in Alaska resulted in economic activity that supported 15,879 jobs in Alaska, provided $545 million of income, and resulted in $123 million in state/local tax revenues. Nonresident angler spending in Alaska in 2007 (economic impact) was $653 million, and this supported 9,437 jobs and $67 million in state/local tax revenues. Total expenditures on guided sportfishing activities in 2007 totaled $416			Yes

Taken directly from the conclusion: The multitude of ecological strategies that we observe in nature arise from the evolutionary 'trade-offs' of costs versus benefits in the process of adaptation to habitats. Natural habitats have at least eight quantitative characters (Figures 6-9) and these must be assessed against the organisms own dimensions in space and time. The author suggests that these characters can be condensed into two axes: durational stability, which assesses spatial heterogeneity against time, and resource level and constancy, which expresses the temporal heterogeneity of the same space. Such a two dimensional treatment cannot encapsulate without exception all the complexity of nature, but it will surely be more realistic than attempts to organize ecological strategies along a single dimension. The author concludes that the value of Figure 13 will have to be tested from both the			
None			
The article indicates that sockeye salmon have the ability to detect relatively small changes in olfactory cues at a very fine scale, and a strong tendency to return to familiar sites, probably using such cues Experimentally displaced salmon returned to their natal site despite much higher likelihood of predation by bears.			Yes
The article underscores the importance of genetically distinct sub-populations to the maintenance of the overall strength of Bristol Bay sockeye salmon.			Yes
This report summarizes information regarding the subsistence use of sockeye salmon and other freshwater fish gathered for a project funded by the US Fish and Wildlife Service, Fisheries Information Services. This project to document traditional ecological knowledge (TEK) was undertaken by the Nondalton Tribal Council in partnership with Lake Clark National Park and Preserve. The information is based on interviews of eighteen Nondalton residents regarding their current and past use of sockeye salmon and other freshwater fish for subsistence. It includes data regarding fishing practices, geographic locations and Dena'ina place names of traditional fishing areas; changes in relative abundance of sockeye salmon and other freshwater fish used for subsistence, and observations of change in the environment. The report does not analyze or			Yes

None			
None			Yes
None			Yes
None			Yes

The publication outlines the history of Lake Clark National Park and Preserve, as well as surrounding areas, from the prehistoric period through the 1980s.			Yes
The document describes Bristol Bay as important breeding habitat for Pacific walrus January through March. Their general ecology and international management are described. The report further indicates a private interest in Alaska in developing the fishery potential of clams in Bristol Bay and examines potential conflict between such an endeavor with walrus management. Authors indicate that disturbance by human activities is a major threat to walrus habitat. A conservation plan is proposed.		Yes	
Marbled murrelet is listed as a threatened species under the US Endangered Species Act. Its range is described as extending as far westward as Bristol Bay. The document details federal actions taken regarding marbled murrelet management and protection.			
The Alaska stock of Pacific walrus is profiled in this document. Its range (including Bristol Bay) is described and illustrated in Figure 1. The world population was last estimated in 2006 at 129,000 animals, the lowest population size estimated for the species. Conflicts between walrus management and commercial fisheries are described, as well as subsistence harvests in the US and Russia. The USFWS received a petition in 2008 to list the Pacific walrus under the US Endangered Species			Yes
Non-digital National Wetland Inventory map for the area surrounding the Pebble Deposit. The map was created utilizing 1978-1986, 1:60,000-scale, color-infrared imagery collected as part of the Alaska High Altitude Photography Acquisition Program (AHAP). The data remains to be digitized, and due date for availability of digital data is unknown. Wetlands professionals indicate the map displays extraordinarily extensive wetlands in the area. Codes to interpret the map may be obtained from:			Yes
The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for Upper Talarik Creek near Iliamna. Similar reports for previous years may be obtained through the USGS			Yes
The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for the North Fork Koktuli River near Iliamna. Similar reports for previous years may be obtained through			Yes
The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for the Koktuli River near Iliamna. Similar reports for previous years may be obtained through the USGS			Yes

None			
None			
None			

This study focuses on the Yukon-Kuskokwim Delta, but highlights potential conflicts between development and subsistence uses.			
The article is the first to define the River Continuum Concept.			Yes
None			

None			Yes
None			Yes
None			Yes
An estimated annual average of 37,500 birds was taken for subsistence use in Bristol Bay between 2001 and 2005 (No survey was conducted in 2003). Of the total harvest, 16,100 birds (43%) were ducks, and 7,500 birds (20%) were geese. Approximately 8,200 birds (22%) were ptarmigan and 3,600 (10%) were spruce grouse. An additional 640 (2%) were swans, 574 (2%) were cranes, and 860 (2%) were other birds (Table 2). Summary tables are presented by species and year. Previous versions of this report may be obtained from the USFWS website: http://library.fws.gov/Publications.html.			

One of the first examinations of early life history of Bristol Bay herring which are the largest herring off western North America and genetically distinct from herring in the Gulf of Alaska and off British Columbia. Average growth rate was near the upper end of the range reported from British Columbia and Washington, but greater than that observed in similar experiments in California. High growth rates in Bristol Bay are attributed to summer surface water temperature in the nearshore zone where herring congregate.			Yes
Similar reports for other years may be found at the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.			Yes
None			Yes
The Bristol Bay population constitutes an estimated 18% of the Pacific Flyway population, though this is one of few studies to examine their distribution, abundance, population structure, and productivity of swans in the area.			
None			Yes
Discusses the evolving perspective on the interconnectedness between salmon and other anadromous fish species to other fish, whales, sea lions, and numerous terrestrial predators and scavengers, suggesting that the view that predators reduce fish availability for humans is both one-sided and overly limited.			Yes

Highlights potential risks to fisheries from road and dam construction			Yes
None			
None			Yes

None			Yes
None			Yes
None			Yes

None			
None			Yes
None	Yes		Yes
None			
None	Yes		Yes
The document describes fecal coliform, other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals), and petroleum sheen sampling and results in the lower Nushagak River. The objective was assess whether or not guide camps and/or villages affect bacterial counts, document present-day water quality conditions, and assess motor boat quantity/usage and petroleum sheen presence on the lower Nushagak. Fecal coliform levels exceeded drinking water quality samples at three sites. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with rare exceptions for dissolved oxygen at one site (super-saturation), pH (below 6.0), and dissolved iron at four sites (in exceedance of national secondary drinking water standards). No	Yes		Yes

The document describes fecal coliform and other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals) sampling and results in the lower Nushagak River. The objective was to build on sampling started the previous year, and to assess sampling locations for suitability for future bioassessment studies. Fecal coliform levels consistently met drinking water quality standards in 2007. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with one exception for dissolved iron at one site (in exceedance of national secondary drinking water standards). Two sites were evaluated for bioassessment suitability and diatom sampling was determined to be the best option	Yes		Yes

gories		Other categories			Filename
Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology	
Yes					ADFG_2006.pdf
Yes	Yes				ADFG_2007a.pdf
Yes	Yes				ADFG_2007b.pdf
	Yes				ADFG_2007c.pdf
Yes					ADFG_2007d.pdf
	Yes				ADFG_2008a.pdf

Yes	Yes				ADFG_2008b.pdf
Yes	Yes				ADFG_2008c.pdf
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	Yes				ADFG_2009b.pdf
	Yes				ADFG_2009c.pdf
	Yes				ADFG_2009d.pdf
					ADFG_2010a.pdf
Yes	Yes				ADFG_2010b (folder containing 41 pdfs including 40 habitat maps)
	Yes				ADFG_2010c.pdf

Yes	Yes				ANDR_1990.pdf
Yes					ASG_2008.pdf
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			Yes		Baldigo_Lawrence_2000.pdf
			Yes		Baldwin_et_al_2003.pdf
			Yes		Barry_et_al_2000.pdf

Yes					Bartonek_Gibson_1972.pdf
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Yes	Yes				Boudreau_et_al_1992.pdf
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Yes				Yes	Cederholm_et_al_1999.pdf

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Yes					DCRA_2010k.pdf

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	Yes				Dye_Schwanke_2009.pdf
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Yes					Ely_Takekawa_1996.pdf
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Yes					Everitt_Braham_1980.pdf
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Yes	Yes				Haley_et_al_1999 (a folder containing the Executive Summary, all chapters, and appendices of the report)
		Yes			Hamilton_Klieforth_2010.pdf

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Yes		Yes			USFWS_2010b.pdf
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Yes	Yes				Zender_2007.pdf

Keywords (if provided by author/s)

Pebble, Porphyry Cu-Au-Mo, Regional Targeting, Southwest Alaska, Kahiltna Terrane

Invertebrates, Metals, Accumulation, Community effects

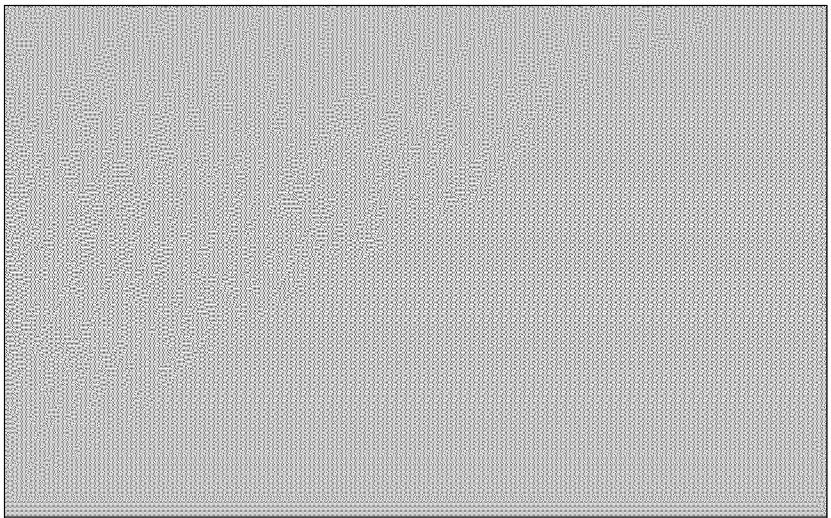
Arctic grayling, Thymallus arcticus, Bristol Bay, age, length, weight
Bristol Bay, Alaska Peninsula, Kodiak, Bristol Bay area, Naknek/Kvichak district, Alagnak River, salmon, trout, adult, harvest monitoring, angler effort index

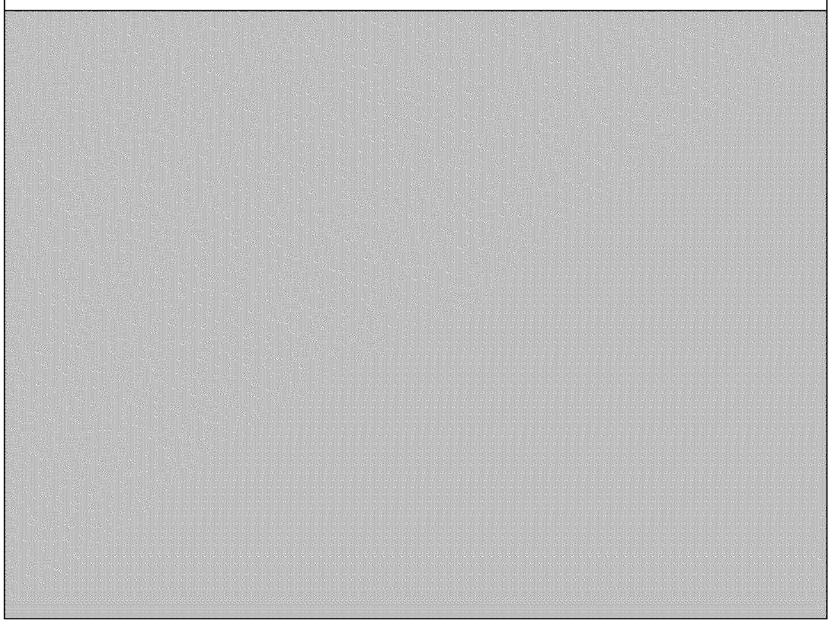
Mammals, small mammals, inventory, museum specimens, Alaska, Southwest Alaska Network, Lake Clark National Park and Preserve, LACL, SWAN
harbor porpoise, *Phocoena phocoena*, abundance, Alaska
Fish, Food, Heavy metal, Food chain effect

Pacific salmon, *Oncorhynchus* spp., sockeye salmon, *Oncorhynchus nerka*, harvest, catch, allocation, commercial fishery, stock, composition, genetics, populaitons, Bristol Bay, Kvichak River, Alagnak Rvier, Naknek River, Egegik River, Ugashik River, Wood River, Igushik River, Nushagak River, Togiak River
Aerial survey, emperor geese, waterbirds, southwest Alaska
sediment pollution, massive sulfides, phosphate, open-pit mining, estuary

Bristol Bay Sport Fish Management Area, Alaska Board of Fisheries, management plan, Alagnak River, Nushagak River, Mulchatna River, Chinook Salmon, *Oncorhynchus tshawytscha*, king salmon, Kvichak River, sockeye salmon, *Oncorhynchus nerka*, rainbow trout, *Oncorhynchus mykiss*

Acid mine drainage, Double-diffusive convection, Geochemistry, Meromixis, Pit lake, Spain





Pacific salmon, sheefish, *Stenodus leucichthys*, whitefish, *Prosopium* spp., *Coregonus* spp., rainbow/steelhead trout, *Oncorhynchus mykiss*, Arctic char/Dolly Varden, *Salvelinus alpinus*, *Salvelinus malma*, northern pike, *Esox lucius*, Chinook salmon, *Oncorhynchus tshawytscha*, sockeye salmon, *Oncorhynchus nerka*, pink salmon, *Oncorhynchus gorbuscha*, chum salmon, *Onchorhynchus keta*, Norton Sound, Port Clarence, Kotzebue, Yukon, Kuskokwim, Bristol
Kvichak District, Kvichak River, Nondalton, Iliamna, Newhalen, Port Alsworth, Sixmile Lake, Iliamna Lake, Newhalen River, Bristol Bay, Southwest Alaska, Pacific salmon, sockeye salmon, *Oncorhynchus nerka*, subsistence fishing, subsistence salmon processing methods, subsistence harvests, case study method, fish camps, traditional ecological knowledge

Alaska, Beringia, Marbled Godwit, *Limosa fedoa beringiae*

Alaska, Beringia, Marbled Godwit, *Limosa fedoa beringiae, Gulo gulo*, harvest, refugia, spatiotemporal analysis, wolverine

aerial surveys, Alaska breeding, distribution, *Gavia,* Gaviidae, loons, population trends, populations

human impacts, hyporheic zone, mining impacts, agricultural impacts, urban impacts, industrial pollution, river regulation, sedimentation, stream restoration, stream management

freshwater harbor seal, *Phoca vitulina*, sockeye salmon, *Oncorhynchus nerka*, Iliamna Lake, scat analysis, seasonal prey, selective predation, consumption patterns
seepage waters, drainage waters, tailings, sulphide mining, heavy metals, As, sulphate, water quality, environmental geochemistry, geochemical modelling, Hitura, Luikonlahti, Finland

bear, nitrogen, nutrient flow, salmon, spruce historical review, competition, predation, parasitism, herbivory, positive interactions, indirect interactions, spatiotemporal effects, impact modulators

time-depth-recorder, TDR, walrus, *Odobenzs rosmaras*, diving, foraging, Bristol Bay
walrus, *Odobenus rosmarus*, haul-out, fidelity, Bristol Bay, foraging, seasonal distribution, transmitters

Alaska, sport, fish, fisheries, catch, harvest, angler, angler-days, survey, salmon, trout, char, Arctic grayling, northern pike, whitefish, burbot, smelt, Pacific halibut, rockfish, lingcod, razor clams, Alaska Statewide Harvest Survey, Statewide Harvest survey, SWHS

fish, bypass, dams, avoidance, preference, flow
Alaska, *Anodonta,* climate change, freshwater mussels, growth variation

Alaska blackfish, Arctic char, Arctic grayling, Bristol Bay, burbot, Dolly Varden, harvest calendars, harvest survey, Igiugig, Iliamna, Kokhanok, Kvichak River watershed, lake trout, Levelock, longnose sucker, Newhalen, Nondalton, northern pike, Pedro Bay, Port Alsworth, rainbow smelt, rainbow trout, traditional ecological knowledge, whitefish

Steller's eider, *Polysticta stelleri*, king eider, *Somateria spectabilis*, migration, population, aerial survey, waterfowl, Bering Sea, Bristol Bay

Infauna, bivalve, inventory, intertidal, soft-sediment, Southwest Alaska Network, Katmai National Park and Preserve, Kenai Fjords National Park, Lake Clark National Park and Preserve

benthic macroinvertebrates, copper, heavy metals, species richness, streams
fluvial, flood plains, mining, sediments, Yellowstone Park, contaminants, pollution

Kvichak River, sockeye salmon, *Oncorhynchus nerka*, stock of concern, commercial fishing, ADF&G, sustainable salmon fisheries policy, Alaska Board of Fisheries, Bristol Bay, Alaska

anadromous fishes, Pacific salmon, *Onchorhynchus,* marine nutrients, stable isotopes, lake, stream, riparian ecosystems, aquatic productivity, resource management

hydrodynamics, rivers -- environmental aspects, streamflow

hyporheic zone, river, floodplain, groundwater, surface water, biogeochemistry, temperature, aquatic habitat
groundwater, river ice, fish habitat, conservation, climate, thermal refugia, northern hydrology, fish movements

Environmental hazards, tailings dam failures, Europe, mine tailings, mono and multivariate statistical analysis

Chionoecetes, eastern Bering Sea, linear regression, recruitment, Tanner crabs
Alaska, birds, inventory, montane, alpine, national parks, passerines, shorebirds

Alaska Peninsula, American wigeon, black scoter, Bristol Bay, cackling goose, Canada goose, common goldeneye, common merganser, disturbance, Eurasian wigeon, greater scaup, greater white-fronted goose, green-winged teal, Kvichak Bay, long-tailed duck, mallard, migration, Naknek River, northern pintail, northern shoveler, red-breasted merganser, staging, trumpeter swan, tundra swan, waterfowl
habitat, conservation, culverts, percids, fish

biogeochemistry, marine-derived nutrients, mixing model, ^{15}N, paleolimnology, primary production, salmon, salmon enhancement, sediments
conservation and management, metapopulation dynamics, population structure, salmon, spatial structure, trout

Tazimina River, rainbow trout, *Oncorhynchus mykiss*, subsistence, mark-recapture, estimation of abundance, sexual maturity composition, length composition, catch per unit effort, Arctic grayling, *Thymallus arcticus*
Aquila chrysaetos, bald eagle, *Canis lupus*, coyote, golden eagle, grizzly bear, *Haliaeetus leucocephalus*, pneumonia, predation, *Rangifer tarandus granti*, *Ursus arctos*, wolf

Canis latrans, Canis lupus, coyotes, Kilbuck caribou herd, lichens, Mulchatna caribou herd, Northern Alaska Peninsula caribou herd, Nushgak caribou herd, nutrition, predation, rabies, *Rangifer tarandus granti*, Southern Alaska Peninsula caribou herd, Unimak caribou herd, volcanic ash, wolves

Alaska, Alaska National Interest Lands, Conservation Act, ANILCA, bears, brown bear, cross-cultural, Eskimo, grizzly, Kuskokwim, subsistence, *Ursus arctos*, Yup'ik
river continuum, stream ecosystems, ecosystem structure, function, resource partitioning, ecosystem stability, community succession, river zonation, stream geomorphology
lotic ecosystems, upstream-downstream linkages, floodplain, groundwater, timescales, spatio-temporal hierarchy

biodiversity, connectivity, floodplains, landscape ecology, natural disturbance
Total Dissolved Solid, TDS, water standards, aquatic organisms, Alaska, salmon

Bristol Bay Management, commercial fisheries, escapement, spawning, sockeye salmon, Chinook salmon, chum salmon, coho salmon, pink salmon, Naknek, Kvichak, Egegik, Ugashik, Wood, Nushagak, Igushik, Togiak
survey, Alaska Peninsula, Bristol Bay, Alaska, phenology, *Cygnus columbianus columbianus*, migration, productivity, tundra swan

Bristol Bay, genetic bottlenecks, Kvichak River, Lake Clark National Park and Preserve, microsatellites, *Oncorhynchus nerka*, radiotelemetry, sockeye salmon, salmon spawning habitat, salmon genetics, subsistence

AMD, heavy metals, Dexing Copper Mine, Yinshan lead–zinc mine, Le An River, China

Additional notes				

This document is a draft and indicates it should not be cited.				

Author	Year	Title	Document Type	Journal/Book Title/Publisher
ADNR (Alaska Department of Natural Resources)	1990	Nushagak and Mulchatna Rivers recreation management plan	Government Document	ADNR, ADFG, and Bristol Bay Coastal Resource Service Area
Brabets, T.P. and R.T. Ourso	2006	Water quality, physical habitat, and biology of the Kijik River basin, Lake Clark National Park and Preserve, Alaska, 2004-2005	Government Document	USGS in cooperation with the National Park Service (NPS)
DCRA (Division of Community and Regional Affairs)	2010	Community Information Summaries (CIS): Clark's Point	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Dillingham	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Ekuk	Web Page	Alaska Community Database

DCRA	2010	Community Information Summaries (CIS): Ekwok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Igiugig	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Iliamna	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): King Salmon	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Kokhanok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Levelock	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Naknek	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): New Stuyahok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Newhalen	Web Page	Alaska Community Database

DCRA	2010	Community Information Summaries (CIS): Nondalton	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Pedro Bay	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Port Alsworth	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Portage Creek	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): South Naknek	Web Page	Alaska Community Database
Kuipers, J.R., A.S. Maest, K.A. MacHardy, and G. Lawson	2006	Comparison of predicted and actual water quality at hardrock mines: the reliability of predictions in environmental impact statements	Report	Kuipers and Associates, Buka Environmental, and Earthworks
Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress reports: Chapter 6. Water Chemistry	Report	Northern Dynasty Mines Inc.

Zamzow, K.	2009	Impacts of exploration on water chemistry and adequancy of baseline water characterization at the Pebble Prospect 1988-2008	Report	Center for Science in Public Participation
Zamzow, K.	2010	Surface water quality near the proposed Pebble Mine, Alaska, 2009, Nushagak, Kvichak, and Chulitna drainage headwaters	Report	Center for Science in Public Participation
Zender Environmental Science and Planning Services	2006	Fecal coliform and water quality assessment of the Lower Nushagak River	Report	Alaska Soil and Water Conservation District and BBNA
Zender Environmental Science and Planning Services	2007	Continuation of fecal coliform and water quality assessment of the Lower Nushagak River (Year 2: data collection, analysis, and report)	Report	BBNA

Pages (and Volume(issue) if applicable)	Abstract
149	This plan guides state land management by the Department of Natural Resources in the Nushagak and Mulchatna drainages and guides coastal consistency review. This plan: 1) identifies goals, management intent, and public use sites for 25 management units in the planning area; 2) specifies management policies for long-term uses (uses that take place at one site on state land for longer than 14 consecutive days), including permanent and temporary facilities, trapping cabins, boat storage, airstrip development, docks, and other uses, and specifies where these uses may be allowed and where they are prohibited; 3) includes guidelines that provide specific management direction for the 25 management units and public use sites; and 4) includes implementation information and
60	The US Geological Survey and the National Park Service conducted a water-quality investigation of the Kijik River Basin in Lake Clark National Park and Preserve from June 2004 to March 2005. The Kijik River Basin was studied because it has a productive sockeye salmon run that is important to the larger Kvichak River watershed. Water-quality, physical habitat, and biological characteristics were assessed. Water type throughout the Kijik River Basin is calcium bicarbonate although Little Kijik River above Kijik Lake does have slightly higher concentrations of sulfate and chloride. Alkalinity concentrations are generally less than 28 milligrams per liter, indicating a low buffering capacity of these waters. Lachbuna Lake traps much of the suspended sediment from the glacier streams in the headwaters of the basin as evidenced by low secchi-disc transparency of 1 to 2 meters and low suspended sediment concentrations in the Kijik River downstream from the lake. Kijik Lake is fed by clearwater streams and has secchi-disc readings ranging from 11 to 15 meters. Streambed sediments collected from four surface sites analyzed for trace elements indicated that arsenic concentrations at all sites were above proposed guidelines. However, arsenic concentrations are due to the local geology, not anthropogenic factors. Benthic macroinvertebrate qualitative multi-habitat samples collected from two sites on the Little Kijik River and two sites on the main stem of the Kijik River indicated a total of 69 taxa present among the four sites. The class Insecta, made up the largest percentage of macroinvertebrates, totaling 70 percent of the families found. The insects were comprised of four orders; Diptera (flies and midges), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera
3	None
3	None
3	None

3	None
3	None
3	None
3	None
3	None
3	None
3	None
3	None
3	None

3	None
3	None
2	None
3	None
3	None
228	None
806	This section discusses the groundwater sampling results from the 2004 field season. The data are analyzed to determine spatial (lateral and vertical) variations and variations with time. The data are also compared with surface water-quality criteria to provide a benchmark for water quality. Based on the results of this analysis, requirements for further data are noted. Groundwater samples were collected in September and October 2004. The study results will be included in the environmental baseline document and are expected to be used for both the design and the permit applications for construction, operation, and closure of the proposed mine. The objective of the following discussion is to report the progress of groundwater sampling and analysis and the current understanding of groundwater chemistry.

N/a	None
N/a	None
	None
35	None

Annotation	404(c) Categ
	Muncipal water supplies
None	Yes
This report is one of very few that provide baseline habitat data in the Bristol Bay drainage area. Kijik Lake is outside of the area that would be directly impacted by mineral development, though the spawning salmon populations migrate through the project area to reach spawning beds in Kijik lake.	Yes
Describes the water source for Clark's Point as spring-fed wells. Water is treated with chlorine and flouride. Commercial fishing forms the economic base for the community. Fish and salmon subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes
Describes the water source for Dillingham as three deep wells. Water is treated and piped to 40% of the community. The remaining 60% use individual wells. Commercial fishing, fish processing and storage, and other support for the fishing industry forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local	Yes
Describes water sources of individuals as wells, or surface water from a nearby unnamed lake. Ekuk was formerly home to a fish packing company. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes

Describes the water source for Ekwok as primarily individual wells. Fish and wildlife subsistence activities are crucial to the livelihood of residents as most residents are not interested in participating in a cash economy. A handful of residents fish commercially, and the village corporation owns a fishing lodge. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be	Yes
Describes the water source for Igiugig as the Kvichak River due to inadequate groundwater supplies. Should mining commence, the risk of drinking water contamination of the Kvichak River exists. Residents depend on the commercial salmon fishery as well as fish and wildlife subsistence activities. Trophy rainbow trout attract sport fishermen to the area, and seven commercial lodges operate in Igiugig, serving sport fishermen and hunters. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with	Yes
Describes water sources for Iliamna as individual wells. Commercial fishing, sport fishing and tourism are listed as major sources of income for the community. Subsistence hunting and fishing is also an important source of livelihood for the community. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices,	Yes
Describes water sources for King Salmon as primarily shallow individual wells, and a small community well for FAA housing. Commercial fishing is important to the King Salmon Economy, as is tourism given its proximity to Katmai National Park and Preserve. Sportfishing is also popular in the area. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be	Yes
Describes water sources for Kokhanok as a piped water system as well as a separate well and treatment facility for the local school. Commercial fishing is an important, if declining economic base in the community. Most residents rely heavily on fish and wildlife subsistence. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website:	Yes
Describes water source for Levelock as individual wells. Commercial fishing, fish processing, and storage form the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes
Describes Naknek's water source as primarily individual wells. Commercial fishing and processing are central to the economy of the village. Government is another source of employment in the village. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA	Yes
Describes water source for New Stuyahok as treated community well water. The salmon fishery forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also	Yes
Describes water sources for Newhalen as treated water derived from a community well. Commercial fishing and sport fishing for trophy rainbow trout provide economic opportunities in Newhalen. Residents also depend on fish and wildlife to support their subsistence lifestyle. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local	Yes

Describes water sources for Nondalton as treated surface water from Six-Mile Lake. Commercial fishing and subsistence hunting are primary sources of livelihood in the village. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website:	Yes
Describes water sources for Pedro Bay as individual wells or surface water from Iliamna Lake. Employment consists largely of commercial fishing and tourism services. Subsistence hunting and fishing is also an important source of livelihood. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes
Describes water sources for Port Alsworth as individual wells or hauled water from nearby surface water sources. The economic base of Port Alsworth relies on lodges and outfitters/guides for summer recreation, as well as limited commercial fishing. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional	Yes
Describes water sources for Portage Creek as hauled from downriver (Portage Creek). Residents depend on fish and wildlife subsistence activities, and a lodge operates during the summer. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website:	Yes
Describes South Naknek's water source as primarily individual wells (surface or groundwater are not indicated), and some piped water. Commercial fishing and processing are central to the economy of the village, and residents depend on subsistence hunting and fishing. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from	Yes
This study reviews the history and accuracy of water quality predictions for major hardrock mines in the United States by comparing actual water quality to the predictions made in Environmental Impact Statements (EISs) and subsequently identifying common causes of water quality impact and prediction failures. In addition, an analysis was conducted to determine if there were inherent risk factors at mines that may predispose an operation to having water quality problems. Of mines analyzed, 76% had mining-related water quality exceedances in surface or groundwater. Eighty-nine percent of mines with acid drainage predicted low acid drainage potential prior to development. Conclusions are provided about the effectiveness of the underlying scientific and engineering principles used to make water quality predictions in EISs. Finally, recommendations are made for regulatory, scientific and engineering approaches that would improve the reliability of water quality predictions at hardrock mine sites. The document may be downloaded at the following website: http://www.mineralpolicy.org/publications_welcome.cfm. For the mines in their study that developed acid drainage, almost all either underestimated or ignored the potential for acid drainage in their EISs. In terms of predicted (post-mitigation) surface water	Yes
Results are provided for specific conductance, pH, water temperature, dissolved oxygen, alkalinity and hardness, nutrients, major ions and dissolved solids, total and dissolved trace elements, and low level mercury. Samples were collected from surface and groundwater in the immediate vicinity of the deposit, as well as the area proposed at the time for the road corridor and port facility. Groundwater is characterized around the deposit by low dissolved solids, near neutral pH, average temperature of 4°C, and high dissolved oxygen with few exceptions. Surface water quality around the deposit generally met water quality standards for aquatic-life criteria with the exception of aluminum and alkalinity. The only noted exceedance to water quality standards in groundwater along the road corridor was the pH value from the Newhalen municipal well which was over the criteria of pH 8.5 during both sampling events. Turbidity values also exceeded state water quality samples, though results were not considered reliable. Aluminum standards were exceeded in most sites sampled, and the authors state site	Yes

None	Yes
None	Yes
The document describes fecal coliform, other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals), and petroleum sheen sampling and results in the lower Nushagak River. The objective was assess whether or not guide camps and/or villages affect bacterial counts, document present-day water quality conditions, and assess motor boat quantity/usage and petroleum sheen presence on the lower Nushagak. Fecal coliform levels exceeded drinking water quality samples at three sites. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with rare exceptions for dissolved oxygen at one site (super-saturation), pH (below 6.0), and dissolved iron at four sites (in exceedance of national secondary drinking water standards). No	Yes
The document describes fecal coliform and other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals) sampling and results in the lower Nushagak River. The objective was to build on sampling started the previous year, and to assess sampling locations for suitability for future bioassessment studies. Fecal coliform levels consistently met drinking water quality standards in 2007. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with one exception for dissolved iron at one site (in exceedance of national secondary drinking water standards). Two sites were evaluated for bioassessment suitability and diatom sampling was determined to be the best option	Yes

404(c) Categories				Other categories		
Shellfish beds	**Fishery areas**	**Wildlife areas**	**Recreation areas**	**Site geology/ hydrology**	**Risk Factors**	**General ecology**
	Yes	Yes	Yes			
	Yes		Yes			
	Yes	Yes				
	Yes	Yes				
	Yes					

	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes				
	Yes	Yes				
	Yes					
	Yes	Yes				
	Yes	Yes	Yes			

	Yes	Yes				
	Yes	Yes	Yes			
	Yes		Yes			
	Yes	Yes				
	Yes	Yes				
	Yes				Yes	
	Yes	Yes				

	Yes			Yes	Yes	
	Yes			Yes		
	Yes	Yes	Yes			
	Yes	Yes	Yes			

Filename	Keywords (if provided by author/s)
ANDR_1990.pdf	
Brabets_Ourso_2006.pdf	
DCRA_2010a.pdf	
DCRA_2010b.pdf	
DCRA_2010c.pdf	

DCRA_2010d.pdf	
DCRA_2010e.pdf	
DCRA_2010f.pdf	
DCRA_2010g.pdf	
DCRA_2010h.pdf	
DCRA_2010i.pdf	
DCRA_2010j.pdf	
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DCRA_2010p.pdf	
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Additional notes			

Author	Year	Title	Document Type	Journal/Book Title/Publisher
ADFG	2009	Estimates of Southcentral Alaska sport fish harvest by species, 2000-2009	Web Page	ADFG, Division of Sport Fish
ADFG	2010	Bristol Bay critical habitat areas (Egegik, Pilot Point, Cinder River, Port Heiden, and Port Moller) management plan	Government Document	ADFG, Division of Habitat and Division of Wildlife Conservation
Fall, J.A.	1990	The division of subsistence of the Alaska Department of Fish and Game: an overview of its research program and findings: 1980-1990	Journal Article	Arctic Anthropology
Jay, C.V., S.D. Farley, and G.W. Garner	2001	Summer diving behavior of male walruses in Bristol Bay, Alaska	Journal Article	Marine Mammal Science
Jennings, G.B., K. Sundet, A.E. Bingham, and D. Sigurdsson	2004	Participation, catch, and harvest in Alaska sport fisheries during 2001	Government Document	ADFG, Division of Sport Fish and Division of Commercial Fisheries

Kendall, N.W., H.B. Rich Jr., L.R. Jensen, and T.P. Quinn	2010	Climate effects on inter-annual variation in growth of the freshwater mussel (*Anodonta beringiana*) in an Alaska lake	Journal Article	Freshwater Biology
Larned, W.W.	2007	Stellar's eider spring migration surveys, Southwest Alaska, 2007	Government Document	US Fish and Wildlife Service, Migratory Bird Management

Lees, D.C.	2006	Guide to intertidal bivalves in Southwest Alaska National Parks: Katmai National Park and Preserve, Kenai Fjords National Park, Lake Clark National Park and Preserve	Government Document	NPS SWAN Inventory and Monitoring Program
Rosenkranz, G.E., Tyler, A.V., and Kruse, G.H.	2001	Effects of water temperature and wind on year-class success of Tanner crabs in Bristol Bay, Alaska	Journal Article	Fisheries Oceanography

USFWS (US Fish and Wildlife Service)	1994	Conservation plan for the Pacific walrus in Alaska	Government Document	US Fish and Wildlife Service, Marine Mammals Management

Pages (and Volume(issue) if applicable)	Abstract
1	None
194	The Bristol Bay critical habitat areas (CHAs) are co-managed by the Alaska Department of Fish and Game (ADFG) in accordance with Alaska Statute 16.20.520-530, and the Alaska Department of Natural Resources (DNR) per AS 38.05. The purpose of the Bristol Bay Critical Habitat Areas Management Plan is to provide consistent, long-range guidance in managing the five CHAs. ADFG has undertaken this comprehensive planning process in order to establish guidelines, policies, and regulations for management of fish and wildlife, habitat, and current and future activities that affect them on the CHAs. This draft plan presents management goals for the CHAs and their resources, and identifies polices to be used in determining whether proposed activities are compatible with the protection of fish and wildlife, their habitats, and public use of the
27(2): 68-92	Since 1980, the Division of Subsistence of the Alaska Department of Fish and Game has conducted research on contemporary hunting, fishing, and gathering in Alaska Native and other rural Alaska communities. This paper describes the division's research program and some the results of the division's studies. First, there is an overview of the state and federal legislation which provides a preference for subsistence uses in resource management and allocation decisions. Next, the division's research methods are discussed, followed by a summary of some of the recent findings about the role of subsistence uses in the mixed subsistence-based economies of Alaskan villages. A description of a "baseline" study in the Central Yup'ik Eskimo village of Manokotak illustrates the kinds of information which the division has collected for about 151 communities. The paper also illustrates how these data have been applied in resource
17(3): 617-631	Pacific walruses (*Odobenzs rosmarzs divergens*) make trips from ice or land haul-out sites to forage for benthic prey. We describe dive and trip characteristics from time-depth-recorder data collected over a one-month period during summer from four male Pacific walruses in Bristol Bay, Alaska. Dives were classified into four types. Shallow (4 m), short (2.7 min), square-shaped dives accounted for 11% of trip time, and many were probably associated with traveling. Shallow (2 m) and very short (0.5 min) dives composed only 1% of trip time. Deep (41 m), long (7.2 min), square-shaped dives accounted for 46% of trip time and were undoubtedly associated with benthic foraging. V-shaped dives ranged widely in depth, were of moderate duration (4.7 min), and composed 3% of trip time. These dives may have been associated with navigation or exploration of the seafloor for potential prey habitat. Surface intervals between dives were similar among dive types, and generally lasted 1-2 min. Total foraging time was strongly correlated with trip duration and there was no apparent diel pattern of diving in any dive type among animals. We found no correlation between dive duration and
238	Since 1977, the Alaska Department of Fish and Game has conducted an annual mail survey to estimate sportfishing participation and harvests (fish kept) statewide by Alaskan fisheries, areas, regions, and species. Since 1990, catches (fish and clams harvested plus fish released) have also been estimated. Detailed findings are presented for 2001. In 2001, an estimated 432,129 anglers fished 2,261,941 days and kept 3,078,100 of the 6,775,786 fish and clams caught. The 3,216,432 fish harvested in 2002 included 788,665 razor clams *Siliqua patula* and 96,304 smelt and capelin Osmeridae. Of the remaining 2,331,463 harvested fish, 1,523,338 (65.3%) were anadromous (sea-run) salmon *Oncorhynchus*, 350,809 (15.1%) were Pacific halibut *Hippoglossus stenolepis*, 120,398 (5.2%) were rockfish Sebastes, 117,063 (5.0%) were rainbow trout *O. mykiss*, 60,994 (2.6%) were Dolly Varden *Salvelinus malma* and Arctic char

55: 2339-2346	1. Warming trends are evident in many parts of the globe but are especially marked at higher latitudes, with complex effects on the biota that include direct effects on growth potential and indirect effects through food webs; 2. Air temperatures have been increasing over the past 50 years in southwestern Alaska, affecting the growth and population dynamics of many organisms, including a variety of aquatic species such as the freshwater mussel *Anodonta beringiana*; 3. We collected freshwater mussels from Iliamna Lake, in the Bristol Bay region of Alaska, and measured their shells to examine climatic effects on growth patterns; 4. Linear mixed effects models and ordinary least square linear regressions revealed strong positive correlations between local air temperatures (especially in May, October and the summer months) and inter-annual
26	Annual spring aerial surveys were initiated in 1992, and repeated in 1993, 1994, 1997, 1998, 2000-2005 and 2007 to monitor the population status of and habitat use by Steller's eiders (*Polysticta stelleri*) staging for spring migration in southwestern Alaska. Since the timing of migration varies, two to three replicate shoreline surveys were conducted each survey year through 1997, to target the optimal timing when most eiders were within the survey area prior to departure to arctic breeding grounds. Fiscal constraints and inclement weather in subsequent years resulted in successful completion of only one survey per year, the timing of which was carefully scheduled using sea ice, weather and observational data from local contacts. We made visual estimates of Steller's eiders and all other identifiable water birds and marine mammals along shorelines, estuaries and shoals where Steller's eiders and other seaducks were known to congregate during migration. In each year where multiple surveys were completed, the highest Steller's eider count was used as that year's population estimate for trend analysis. Annual Steller's eider raw counts are 137,904 (1992); 88,636 (1993); 107,589 (1994); 90,269 (1997), 84,459 (1998), 68,956 (2000), 58,231 (2001), 54,191 (2002), 77,329 (2003), 82,455 (2004), 79,022 (2005) and 87,353 (2007). The long-term average from 1992 to 2007 is 84,700. Correcting recent estimates using extrapolated data from sampled shoal habitats, the totals are 72,953 (2000), 60,656 (2001), 56,704 (2002), 77,369 (2003), 82,772 (2004), 79,022 (2005), and 87,400 (2007). We suspect that the low population estimates obtained from 2000 through 2002 were due in part to a portion of the eiders migrating northward during the survey, thus escaping detection by the survey crew. This hypothesis was supported by satellite telemetry data which indicated migration within the study area during the survey of 2002. We therefore initiated the 2003 through 2007 surveys in early April, encountering most eiders before they moved from Alaska Peninsula lagoons to Kuskokwim Bay and other more northerly habitats. Unexpanded long-term survey data indicate a 2.8 percent average annual decline in

65	The purpose of this guide is to provide assistance to visitors to the Southwest Alaska Network (SWAN) national parks and National Park Service staff in identifying, understanding, and enjoying bivalves found in intertidal sediments in the SWAN parks. We have provided brief sections on the ecology of these clams, including comments on their habitats and feeding types, and a descriptive guide to the clams. The descriptive guide includes drawings and photographs to depict the appearance of the clams both in the hand and, where possible, the appearance of distinguishing indicators of their presence in the field. For each species, we have included a brief description of the clam, its typical habitat, and its distribution among the parks and in the North Pacific. Bivalves are a critical source of nutrition for major predators such as bears, sea otters, sea (diving) ducks, shorebirds and other invertebrates at some time during the year. For example, bears along the KATM coast achieve higher rates of energy from razor and softshell clams than those foraging on vegetation (Smith 2004). In addition to supporting the bears, sea otters, diving ducks, and shorebirds for millions of years, clams have been a major source of food for native Alaskans since their arrival in Alaska 15,000 to 20,000 years ago. They have been important in the success of native cultures in coastal environments. Clams exhibit longevity and lack of mobility, and thus are good indicators of long-term conditions (Bennett 2006). It can be assumed that beaches supporting reasonable numbers of longlived clams are stable and "healthy." This guide includes descriptions of twenty-nine species in thirteen families that were found in surveys of beaches in three SWAN national parks during the summers of 2004 and 2005 (Lees and Driskell 2004, 2006a, and 2006b). The parks surveyed were Katmai National Park and Preserve (KATM), Kenai Fjord National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). Species composition of the clams varied considerably by park. Approximately the same number of clam species was observed in KATM and KEFJ, but LACL supports far fewer species. Only Baltic macomas and softshell clams were found
10(1): 1-12	We investigated five a priori hypotheses on factors affecting year-class success of commercially exploited Tanner crabs, Chionoecetes bairdi, in Bristol Bay, Alaska, through correlation analysis and multiple regression modelling. Estimates of recruitment from Zheng et al.'s (1998; Can. Spec. Publ. Fish. Aquat. Sci. 125:97±105) length-based analysis of assessment survey and commercial catch data were used to index year-class strength. This work extends results of an earlier study (Rosenkranz et al., 1998; Alaska Fish. Res. Bull. 5:18±24), which reported positive correlations between Tanner crab year-class size and northeast (NE) winds during the spring larval period, by considering the effects of nondirectional wind speed, bottom and surface water temperature, and abundance of the potential predators sockeye salmon (Oncorhynchus nerka) and Pacific cod (Gadus macrocephalus). No relationships were found between year-class size and mean wind speed or predator abundance, but positive correlations were found with bottom temperatures during gonadal development and egg incubation. Linear regression models with the independent variables NE wind and bottom temperature accounted for about half the variability in the year-class strength index (r-squared=0.50 for males, r-squared=0.48 for females). Anomalously cold bottom temperatures may adversely affect the Tanner crab reproductive cycle, and NE winds may promote coastal upwelling while

79	This Conservation Plan for the Pacific Walrus in Alaska has been approved by the US Fish and Wildlife Service. During the 1988 reauthorization of the Marine Mammal Protection Act, Congress suggested conservation plans: (1) be prepared where they could benefit the population, and (2) provide certain background material and develop a strategy for achieving the primary goal of the MMPA of maintaining population stocks with their optimum sustainable population level. This plan has been developed accordingly. The Conservation Plan does not necessarily represent official positions or approval by cooperating agencies or organizations. The Conservation Plan was prepared by the staff, Marine Mammals Management, US Fish and Wildlife Service with the assistance of the Marine Mammal Commission, the Eskimo Walrus Commission, and the University of Alaska to delineate reasonable actions believed required to conserve the Pacific walrus population within the requirements of the Marine Mammal Protection Act of 1972, as amended. While many of the contributions and recommendations made by these organizations have been incorporated into this Plan, the Plan does not necessarily represent the views of these groups, nor does it always represent a consensus of these views. This Conservation Plan will be reviewed on a periodic basis

Annotation	404(c) Categ Muncipal water supplies
A table with sport fish harvest in southcentral Alaska (including Bristol Bay) listed by species for salmon, resident fish, as well as smelt, halibut, shark, rockfish, lingcod, Pacific cod, razor clams, and other fish. May be obtained from the ADFG website:	
This document includes 40 maps outlining land designations and habitat areas in Bristol Bay for marine invertebrate gathering, waterfowl trapping, salmon, freshwater fish, marine mammals, caribou, geese, shorebirds, gulls and terns, eagles, Stellar's eiders, brown bears, and swans for each community.	
The report includes a map of areas used by Manokotak hunters to harvest moose and marine mammals, and documents edible weight of subsistence for Manokotak and Dillingham at 2006 and 715 pounds, respectively. Mean household harvest is documented for 19 Bristol Bay communities for salmon, other fish, marine invertebrates (butter and razor clams), land mammals, marine mammals, furbearers, birds and eggs, and plants. Response to growing hunting pressure by recreational hunters is discussed.	
Describes diving behavior of Pacific walrsus in Bristol Bay including foraging for bivalve molluscs in the region.	
Sport fishing participation is broken out by regions in tables at the end of the report. Bristol Bay is included in southcentral Alaska for the purposes of this report.	

None	
The majority of world population of Stellar's eiders (a species listed as threatened under the US Endangered Species Act) migrates along the Bristol Bay coast of the Alaska Peninsula in the spring, and crosses the Bay. It is found in and near lagoons and shoals rich in benthic invertebrate prey. Maps of King eider flock distribution are presented in Figures 2 through 8. A list of other species observed during the surveys is included at the end of the document.	

Although the guide focuses on national parks around Bristol Bay as opposed to areas which would be directly impacted by development, it is some of the only data available regarding shellfish beds for the region. Species assemblages in Bristol Bay presumably resemble some of those described herein.	
Tanner crabs are described as an economically important pot fishery target.	

The document describes Bristol Bay as important breeding habitat for Pacific walrus January through March. Their general ecology and international management are described. The report further indicates a private interest in Alaska in developing the fishery potential of clams in Bristol Bay and examines potential conflict between such an endeavor with walrus management. Authors indicate that disturbance by human activities is a major threat to walrus habitat. A conservation plan is proposed.	

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
Yes	Yes		Yes			
Yes	Yes	Yes	Yes			
Yes	Yes	Yes	Yes			
Yes		Yes				
Yes	Yes		Yes			

Yes	Yes					
Yes		Yes				

Yes		Yes				
Yes						

Yes		Yes				

Filename	Keywords (if provided by author/s)
ADFG_2009d.pdf	
ADFG_2010b (folder containing 41 pdfs including 40 habitat maps)	
Fall_1990.pdf	
Jay_et_al_2001.pdf	time-depth-recorder, TDR, walrus, *Odobenzs rosmaras*, diving, foraging, Bristol Bay
Jennings_et_al_2006.pdf	Alaska, sport, fish, fisheries, catch, harvest, angler, angler-days, survey, salmon, trout, char, Arctic grayling, northern pike, whitefish, burbot, smelt, Pacific halibut, rockfish, lingcod, razor clams, Alaska Statewide Harvest Survey, Statewide Harvest survey, SWHS

Kendall_et_al_2010.pdf	Alaska, *Anodonta,* climate change, freshwater mussels, growth variation
Larned_2007.pdf	Steller's eider, *Polysticta stelleri*, king eider, *Somateria spectabilis*, migration, population, aerial survey, waterfowl, Bering Sea, Bristol Bay

Lees_2006.pdf	Infauna, bivalve, inventory, intertidal, soft-sediment, Southwest Alaska Network, Katmai National Park and Preserve, Kenai Fjords National Park, Lake Clark National Park and Preserve
Rosenkranz_et_al_2001.pdf	Chionoecetes, eastern Bering Sea, linear regression, recruitment, Tanner crabs

USFWS_1994.pdf	

Additional notes			
This document is a draft and indicates it should not be cited.			

Author	Year	Title	Document Type	Journal/Book Title/Publisher
ADFG	2007	Economic impacts and contributions of sportfishing in Alaska	Government Document	ADFG, Division of Sport Fish
ADFG	2008	Anadromous Waters Atlas Naknek Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Anadromous Water Atlas Dillingham Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Anadromous Waters Atlas Iliamna Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Anadromous Waters Atlas Lake Clark Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Estimates of Southcentral Alaska sport fish harvest by species, 2000-2009	Web Page	ADFG, Division of Sport Fish
ADFG	2010	2010 Bristol Bay salmon season summary	Government Document	ADFG, Division of Commercial Fisheries

ADFG	2010	Bristol Bay critical habitat areas (Egegik, Pilot Point, Cinder River, Port Heiden, and Port Moller) management plan	Government Document	ADFG, Division of Habitat and Division of Wildlife Conservation
ADFG	2010	Southwest Alaska rainbow management policies	Government Document	ADFG
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DCRA	2010	Community Information Summaries (CIS): Dillingham	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Ekuk	Web Page	Alaska Community Database

DCRA	2010	Community Information Summaries (CIS): Ekwok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Igiugig	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Iliamna	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): King Salmon	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Kokhanok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Levelock	Web Page	Alaska Community Database

DCRA	2010	Community Information Summaries (CIS): Naknek	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): New Stuyahok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Newhalen	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Nondalton	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Pedro Bay	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Port Alsworth	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Portage Creek	Web Page	Alaska Community Database

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Woody, C.A. and D. Young	2006	Life history and essential habitats of humpback whitefish in Lake Clark National Park, Kvichak River watershed, Alaska	Report	US Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program

Woody, C.A. and S.L. O'Neal	2010	Fish surveys in headwater streams of the Nushagak and Kvichak River drainages Bristol Bay, Alaska, 2008-2010	Report	The Nature Conservancy
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Zamzow, K.	2009	Impacts of exploration on water chemistry and adequancy of baseline water characterization at the Pebble Prospect 1988-2008	Report	Center for Science in Public Participation
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Zender Environmental Science and Planning Services	2007	Continuation of fecal coliform and water quality assessment of the Lower Nushagak River (Year 2: data collection, analysis, and report)	Report	BBNA

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Pages (and Volume(issue) if applicable)	Abstract
12	None
1	None
1	None
1	None
1	None
1	None
6	None

194	The Bristol Bay critical habitat areas (CHAs) are co-managed by the Alaska Department of Fish and Game (ADFG) in accordance with Alaska Statute 16.20.520-530, and the Alaska Department of Natural Resources (DNR) per AS 38.05. The purpose of the Bristol Bay Critical Habitat Areas Management Plan is to provide consistent, long-range guidance in managing the five CHAs. ADFG has undertaken this comprehensive planning process in order to establish guidelines, policies, and regulations for management of fish and wildlife, habitat, and current and future activities that affect them on the CHAs. This draft plan presents management goals for the CHAs and their resources, and identifies polices to be used in determining whether proposed activities are compatible with the protection of fish and wildlife, their habitats, and public use of the CHAs. The goals and policies of this plan are adopted as regulation. The plan does not address hunting or fishing regulations, which are the purview of the Alaska Boards of Fish and Game.
2	New regulations based on wild trout management policies now apply to popular rainbow trout waters in Southwest Alaska. These regulations were passed by the Alaska Board of Fisheries after two years of public meetings and involvement by anglers, guides, lodge owners, area residents, and the department. Management policies were adopted by the board to sustain quality wild stock rainbow populations while providing a variety of sport fishing opportunities through establishment of special areas. Also, the new board policies allow for economic development while acknowledging the value of the rainbow trout fishery to the people of Alaska.
149	This plan guides state land management by the Department of Natural Resources in the Nushagak and Mulchatna drainages and guides coastal consistency review. This plan: 1) identifies goals, management intent, and public use sites for 25 management units in the planning area; 2) specifies management policies for long-term uses (uses that take place at one site on state land for longer than 14 consecutive days), including permanent and temporary facilities, trapping cabins, boat storage, airstrip development, docks, and other uses, and specifies where these uses may be allowed and where they are prohibited; 3) includes guidelines that provide specific management direction for the 25 management units and public use sites; and 4) includes implementation information and recommendations for future management of the planning area. This plan is consistent with the goals and guidelines of the Bristol Bay Area Plan and the Bristol Bay Coastal Management Plan.

129(1): 60-76	The effects of acidification in lotic systems are not well documented. Spatial and temporal variability of habitat and water quality complicate the evaluation of acidification effects in streams and rivers. The Neversink River in the Catskill Mountains of southeastern New York, the tributaries of which vary from well buffered to severely acidified, provided an opportunity to investigate the extent and magnitude of acidification effects on fish communities of headwater systems. Composition of fish communities, water quality, stream hydrology, stream habitat, and physiographic factors were characterized from 1991 to 1995 at 16 first- to fourth-order sites in the basin. Correlation and regression analyses were used to develop empirical models and to assess the relations among fish species richness, total fish density, and total fish biomass and environmental variables. Chronic and episodic acidification and elevated concentrations of inorganic monomeric aluminum were common, and fish populations were rare or absent from several sites in the upper reaches of the basin; as many as six fish species were collected from sites in the lower reaches of the basin. Species distributions and species richness were most highly related to stream pH, acid-neutralizing capacity (ANC), inorganic monomeric aluminum (Al_{im}), calcium $(Ca)^{2+}$, and potassium $(K)^{+*}$ concentrations, site elevation, watershed drainage area, and water temperature. Fish density was most highly related to stream pH, Al_{im}, ANC, K^+, Ca^{2+}, and magnesium $(Mg)^{2+}$ concentrations. Fish biomass, unlike species richness and fish density, was most highly related to physical habitat characteristics, water temperature, and concentrations of Mg^{2+} and silicon. Acidity characteristics were of secondary importance to fish biomass at all but the most severely acidified sites. Our results indicate that (1) the total biomass of fish communities was not seriously affected at moderately to strongly acidified sites; (2) species richness and total density of fish were adversely affected at strongly to severely acidified sites; and (3) possible changes in competitive interactions may mitigate negative effects of acidification on fish communities in parts of the Neversink River Basin.
22(10): 2266-2274	The sublethal effects of copper on the sensory physiology of juvenile coho salmon (*Oncorhynchus kisutch*) were evaluated. In vivo field potential recordings from the olfactory epithelium (electro-olfactograms) were used to measure the impacts of copper on the responses of olfactory receptor neurons to natural odorants (L-serine and taurocholic acid) and an odorant mixture (L-arginine, L-aspartic acid, L-leucine, and L-serine) over a range of stimulus concentrations. Increases in copper impaired the neurophysiological response to all odorants within 10 min of exposure. The inhibitory effects of copper (1.0 - 20.0 µg/L) were dose-dependent and they were not influenced by water hardness. Toxicity thresholds for the different receptor pathways were determined by using the benchmark dose method and found to be similar (a 2.3 - 3.0 µg/L increase in total dissolved copper over background). Collectively, examination of these data indicates that copper is broadly toxic to the salmon olfactory nervous system. Consequently, short-term influxes of copper to surface waters may interfere with olfactory-mediated behaviors that are critical for the survival and migratory success of wild salmonids.

57: 2032-2043	The abandoned copper mine at Britannia Beach, British Columbia, has been releasing acid mine drainage (AMD) into Howe Sound for many years. To assess the impacts of AMD on juvenile salmonids in the Britannia Creek estuary, we compared fish abundance, distribution, and survival at contaminated sites near the creek with uncontaminated areas in Howe Sound. Water quality near Britannia Creek was poor, particularly in spring when dissolved Cu exceeded 1.0 $mg \cdot L^{-1}$ and pH was less than 6. Beach seine surveys conducted during April–August 1997 and March–May 1998 showed that chum salmon (*Oncorhynchus keta*) fry abundance was significantly lower near Britannia Creek mouth ($0–1.2 \cdot 100\ m^{-2}$) than in reference areas ($11.5–31.4 \cdot 100\ m^{-2}$). Laboratory bioassays confirmed that AMD from Britannia Mine was toxic to juvenile chinook (*Oncorhynchus tshawytscha*) and chum salmon (96-h LC50 = 0.7–29.7% in fresh- water and 12.6–62.2% in 10 ppt water). Chinook salmon smolts transplanted to surface cages near Britannia Creek experienced 100% mortality within 2 days. These results demonstrated that juvenile salmonids are vulnerable to AMD from Britannia Creek: their abundance peaks during spring when Cu concentrations are highest and toxicity is greatest in surface freshwater, which matches their preferred vertical distribution.
74	Protection of Washington State's salmonids requires that transportation officials consider the effect of suspended sediments released into streams during transportation projects. Many state and provincial criteria are based on a threshold of exceedance for background levels of turbidity. However, determining natural background levels of turbidity is a difficult endeavor. The inconsistent correlation between turbidity measurements and mass of suspended solids, as well as the difficulty in achieving repeatability using turbidimeters contributes to concerns that turbidity may not be a consistent and reliable tool determining the effects of suspended solids on salmonids. Other factors, such as life stage, time of year, size and angularity of sediment, availability of off-channel and tributary habitat, and composition of sediment may be more telling in determining the effect of sediment on salmonids in Northwestern rivers. For short-term construction projects, operators will need to measure background turbidities on a case by case basis to determine if they are exceeding regulations. However, transportation projects may also produce long-term, chronic effects. To adequately protect salmonids during their freshwater residence, TSS data on physiological, behavioral, and habitat effects should be viewed in a layer context, incorporating both the spatial geometry of suitable habitat and the temporal changes associated with life history, year class, and climate variability. Spatial and temporal considerations provide the foundation to decipher legacy effects as well as cumulative and synergistic effects on salmonid protection and recovery.

18(2): 299-307	This study quantitatively evaluated the relationships among As, Co, and Cu concentrations in exposure media (surface water, sediment, and *aufwuchs*), As, Co, and Cu concentrations in aquatic macroinvertebrates, and invertebrate community structure in a mine-affected stream. Concentrations of As, Co, and Cu were significantly elevated in both exposure media and invertebrate tissue downstream from the mine. Copper in invertebrates was significantly correlated only with Cu in *aufwuchs*, and Co in invertebrates was significantly correlated only with dissolved Co in water, suggesting different mechanisms of invertebrate accumulation for these two metals. The invertebrate community was severely affected downstream from the mine, with a loss of metals-sensitive species and reductions in both total biomass and number of species. Total abundance was not affected. Principal components analysis was performed on the invertebrate community data to develop a simplified description of community response to mine inputs. Based on this index, metal concentrations in invertebrates were poor predictors of community structure. Copper concentrations in water, combined with an estimate of invertebrate drift from clean tributaries, were statistically significant predictors of community structure.
4: 371-374	Some water quality standards established by the states permit only minor increases in suspended sediment when background turbidity is low, allow greater absolute increases as background levels rise, and do not consider acclimation of stream biota to high turbidity. Juvenile coho salmon (*Oncorhynchus kisutch*) were subjected to experimentally elevated concentrations of suspended sediment and did not avoid moderate turbidity increases when background levels were low, but exhibited significant avoidance when turbidity exceeded a threshold that was relatively high (>70 NTU) and was varied according to previous suspended sediment exposure.
122(4): 550-559	Sockeye salmon *Oncorhynchus nerka* spawn in many streams and along lake beaches of the Kvichak River system in Alaska, but fry from the distinct spawning areas reside in a common nursery habitat, Iliamna Lake. In addition, Kvichak River subpopulations have similar dates of adult entry into fresh water, similar migration distances, and similar spawning dates. These similarities in rearing environments and migratory timing enabled us to test the hypothesis that differences in spawning and incubation habitat alone can promote differentiation in traits associated with reproductive success. River-spawning sockeye salmon tended to be larger at age and older than those spawning along island beaches. Females from rivers were more fecund but had smaller eggs than the beach-spawning females. Males from beaches were deeper-bodied and (in one comparison) had relatively longer lower jaws than males from rivers. The tendency of river-spawning females to mature later than beach spawners may be related to a higher marine growth rate and greater increase in fecundity with length. Differences in male morphology may reflect the countervailing pressures of natural and sexual selection. We conclude that these patterns of variation reflect, in part, adaptations to spawning and incubation conditions of the populations.

14: 289-295	The effect of an embedded substratum on emigration and growth in juvenile brown trout was investigated in an artificial stream with sand added to produce sections of embedded or nonembedded substratum. Fish were allowed to leave the sections and were caught daily in a downstream trap. After catching and counting, fish were put back in their original section in order to keep the same amount of fish. Captures were high only on the first days after fish release. During the first 6 days after fish release, downstream-moving fish were more numerous in the embedded than in the nonembedded sections. The embedded substratum significantly decreased the final mean body weight and condition factor and increased heterogeneity in fish size. We suggest that a decrease in the habitat carrying capacity for juveniles could be the main factor explaining this result.
9	None
60	The US Geological Survey and the National Park Service conducted a water-quality investigation of the Kijik River Basin in Lake Clark National Park and Preserve from June 2004 to March 2005. The Kijik River Basin was studied because it has a productive sockeye salmon run that is important to the larger Kvichak River watershed. Water-quality, physical habitat, and biological characteristics were assessed. Water type throughout the Kijik River Basin is calcium bicarbonate although Little Kijik River above Kijik Lake does have slightly higher concentrations of sulfate and chloride. Alkalinity concentrations are generally less than 28 milligrams per liter, indicating a low buffering capacity of these waters. Lachbuna Lake traps much of the suspended sediment from the glacier streams in the headwaters of the basin as evidenced by low secchi-disc transparency of 1 to 2 meters and low suspended sediment concentrations in the Kijik River downstream from the lake. Kijik Lake is fed by clearwater streams and has secchi-disc readings ranging from 11 to 15 meters. Streambed sediments collected from four surface sites analyzed for trace elements indicated that arsenic concentrations at all sites were above proposed guidelines. However, arsenic concentrations are due to the local geology, not anthropogenic factors. Benthic macroinvertebrate qualitative multi-habitat samples collected from two sites on the Little Kijik River and two sites on the main stem of the Kijik River indicated a total of 69 taxa present among the four sites. The class Insecta, made up the largest percentage of macroinvertebrates, totaling 70 percent of the families found. The insects were comprised of four orders; Diptera (flies and midges), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). One-hundred twenty-two species of periphytic algae were identified in qualitative multi-habitat samples collected at the four stream sites. Eight species of non-motile, diatoms were collected from all four stream sites suggesting that the areas from which they were collected are relatively stable and unaffected by sedimentation.

141	Cominco Alaska Exploration is pursuing a mineral exploration project, the Pebble Copper Prospect, in the area of the headwaters of the Koktuli River and Upper Talarik Creek, north of Lake Iliamna. The prospect site is on the divide separating the Upper Talarik Creek and South Fork Koktuli River watersheds, and very near the divide between these two watersheds and the upper North Fork Koktuli River watershed. Reconnaissance level investigations were undertaken in August of this year to gain an understandng of the distribution and relative abundance of fish species in the area and of the factors which may be limiting that distribution and relative abundance. Information was gathered on fish occurrence within the upper basins of the north and south forks of the Koktuli River, Upper Talarik Creek, and the small basins tributary to the Chulitna River and on factors influencing distribution and relative abundance. Potential impacts of prospect development will be addressed in later phases of investigations. The purposes of this Technical Memorandum is to summarize the results of these preliminary investigations.
67(2): 405-459	An intensive research program was conducted in 1961 and 1962 by the Bureau of Commercial Fisheries Biological Laboratory, Auke Bay, Alaska, and the Fisheries Research Institute, University of Washington, with the cooperation of the Alaska Department of Fish and Game. Many sockeye salmon river systems were studied concurrently with essentially the same techniques so that systems covering the entire range of production levels could be compared. The general objective of this research was to determine the optimum escapement of sockeye salmon for each of the major systems. This was accomplished through integration of the results of several related studies: (1) summarization and analysis of historical and current data on runs of adult sockeye salmon, (2) delineation and description of spawning areas and estimation of their capacities, (3) delineation and description of the nursery areas and estimation of their capacities. The major systems studied were the Wood, Kvichak, Naknek, and Ugashik systems, which enter Bristol Bay; the Chignik system, on the south side of the Alaska Peninsula; and the Karluk system, on Kodiak Island. Adult sockeye salmon in the commercial catches and escapements, and sockeye salmon smolts, were counted and sampled. Spawning grounds were surveyed to determine their size and quality and the distribution and abundance of spawners. Bathymetric maps were prepared for some of the nursery lakes. Intensive limnological studies, including a major effort to measure primary productivity, were made on many nursery lakes. Several types of gear sampled juvenile sockeye salmon and associated species in the lakes. Interim optimum or target escapements required for highest production on a sustained-yield basis have been established for each major system.

443(26): 989-992	Over the past decade, accelerating rates of species extinction have prompted an increasing number of studies to reduce species diversity experimentally and examine how this alters the efficiency by which communities capture resources and convert those into biomass. So far, the generality of patterns and processes observed in individual studies have been the subjects of considerable debate. Here we present a formal meta-analysis of studies that have experimentally manipulated species diversity to examine how it affects the functioning of numerous trophic groups in multiple types of ecosystem. We show that the average effect of decreasing species richness is to decrease the abundance or biomass of the focal trophic group, leading to less complete depletion of resources used by that group. At the same time, analyses reveal that the standing stock of, and resource depletion by, the most species-rich polyculture tends to be no different from that of the single most productive species used in an experiment. Of the known mechanisms that might explain these trends, results are most consistent with what is called the 'sampling effect', which occurs when diverse communities are more likely to contain and become dominated by the most productive species. Whether this mechanism is widespread in natural communities is currently controversial. Patterns we report are remarkably consistent for four different trophic groups (producers, herbivores, detritivores and predators) and two major ecosystem types (aquatic and terrestrial). Collectively, our analyses suggest that the average species loss does indeed affect the functioning of a wide variety of organisms and ecosystems, but the magnitude of these effects is ultimately determined by the identity of species that are going extinct.
24(10): 6-15	Pacific salmon and other anadromous salmonids represent a major vector for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Salmon carcasses provide nutrients and energy to biota within aquatic and terrestrial ecosystems through various pathways. In this paper we review and synthesize the growing number of studies documenting this process in different localities. We also discuss the implications for maintaining the nutrient feedback system. Our findings show that future management will need to view spawning salmon and their carcasses as important habitat components for sustaining the production of fish as well as other salmon-dependent species within watersheds.
145	Mean length, mean weight, percentage by age class, sample size, and standard error term statistics are presented by gear type for samples of Arctic grayling *Thymallus arcticus* collected over a 26-year period (1964 through 1989) from waters of Southwest Alaska. Of the 10,298 records summarized in tabular form, age estimates, based on scale samples, are available for approximately 7,043 records. This document is the most complete and uniform summary of available size and age information yet to be published for wild Arctic grayling stocks found in Southwest Alaska.

15	An angler effort survey was conducted on the Alagnak River from 10 June - 10 August, 2000. This was a collaborative effort between the Alaska Department of Fish and Game - Division of Sport Fish (ADFG), the National Park Service (NPS), and the Bristol Bay Native Association (BBNA). ADFG provided detailed data collection instructions and technical review of the project design. Several problems were encountered during the project and it was not completed as scheduled. However, the data collected indicated that during the study year there was heavier use of the lower river than the upper river and peak use occurred during July. Rafts were most common in the upper river and decreased in frequency with each downstream segment. Overall use was dominated by the salmon fishery in the tidal section. These data were subsequently used by ADFG to help design a more comprehensive Alagnak River Chinook and coho salmon creel survey conducted during 2001 and 2002.
110: 281-286	Juvenile coho salmon (*Oncorhynchus kisutch*) production (tissue elaboration) was monitored in 12 laboratory streams under six replicate treatment levels of fine sedimentation. Increasing sedimentation supressed fish production. Our data confirm that habitats of salmonid juveniles, as well as spawning areas, should be protected against fine sediments. Substrate Score, a visual technique for evaluating stream substrate quality, correlated closely with both the geometric mean particle size of the substrate and fish production, and can be easily applied in the field.
24(11): 631-641	None
73(1): 91-98	1. The uptake of heavy metals via the alimentary tract can be an important factor for the metal budget of fish. 2. Concepts such as biomagnification, bioaccumulation, biotransference, or concentration factors, convey little information about the real threat originating from heavy metals in an aquatic food chain. 3. In polluted aquatic ecosystems the transfer of metals through food chains can be high enough to bring about harmful concentrations in the tissues of fish. This relationship is called the food chain effect. 4. Two kinds of ecological factors influence the food chain effect: firstly, high levels of contamination of the food, and, secondly, the reduction of species diversity. When susceptible species are eliminated, metal-tolerant food organisms may become dominant. Their tolerance may be based either on their ability to accumulate excessive amounts of metals or to exclude heavy metals from the tissues. These two strategies represent feedback mechanisms which may enhance or weaken the food chain effect. 5. It is concluded that future investigations on transference of heavy metals to fish must take into more careful consideration the specific ecological situation of a given environment.

134	Bristol Bay Management Area supports the largest sockeye salmon *Oncorhynchus nerka* fishery in the world. A key to the sustainability of the fishery has been conservation of sockeye salmon biodiversity, which is derived from a wide variety of life history types and multiple distinct, locally adapted populations. Alaska Department of Fish and Game is responsible for managing commercial fisheries in Bristol Bay under the sustained yield principal. Accurately estimating the stock composition of catch within the fishing districts is critical to determining the total run (catch and escapement) of each stock, especially considering that sockeye salmon stocks in Bristol Bay can be exploited at rates up to 80%. In recent years, the department has developed a genetics program for sockeye salmon in Bristol Bay to develop and apply genetic methods to identify the stock composition of mixtures (mixed stock analysis; MSA). Here we investigate where fish from different stocks are captured in the commercial fishing districts during 2006, 2007, and 2008 and compare these results to those based on the traditionally used method of age-based MSA. Results from genetic data support results from previous studies showing that high proportions of the stocks captured in fishing districts were under- or over estimated by large amounts (2%-435%), and that these new estimates resulted in considerably different estimates of total run by stock (1%-164%) compared to traditional methods. The magnitude of these differences varied among years, highlighting the difficulties for developing standardized adjustment of results from the age-composition method. Future analyses will combine the genetic estimates presented in this report with data from other years to produce more accurate estimates of total run, which will likely lead to changes in escapement goals for stocks in Bristol Bay.
3	None
3	None
3	None

3	None
3	None
3	None
3	None
3	None
3	None

3	None
3	None
3	None
3	None
3	None
2	None
3	None

3	None
310	Information about the red salmon runs and the spawning streams and beaches in the Kvichak River System, Bristol Bay, Alaska, is cataloged in this volume. The material is compiled from data obtained from spawning ground surveys made in the area since 1955 by the Fisheries Research Institute of the University of Washington. Earlier work was financed by the salmon canners of Bristol Bay. In recent years the work was supported by the Bureau of Commercial Fisheries. For each spawning stream or beach, the catalog gives, whenever available, the stream catalog number, name, location, and physical description, including dimensions, bottom quality, flow barriers, watershed size and type, vegetation, gradient, water velocity, estimated flow, air and water temperature, and general information including shelter, survey routes and methods, personal-use fisheries, and wildlife species. Then a description of red salmon runs to the area is listed, including magnitude of the run and timing and distribution of spawning. Estimates of numbers of red salmon to each stream or beach are listed chronologically under a separate entry entitled "Summary of Surveys."
138: 1207-1219	A large and growing body of literature has documented the transfer of marine-derived nutrients from the ocean to freshwater and riparian systems by semelparous Pacific salmon *Oncorhynchus* spp. The pathways by which these nutrients reach resident fish are often indirect, and the evidence for direct benefits to the resident fish is not always conclusive. However, the consumption of salmon tissue (in one form or another) by resident fish would constitute a direct and efficient pathway for energy transfer. We studied a population of small-bodied, nonanadromous Dolly Varden *Salvelinus malma* feeding on the fry and eggs of sockeye salmon *O. nerka* and blowfly (family Calliphoridae) larvae that had fed on salmon carcasses at a series of spring-fed and otherwise unproductive ponds in southwestern Alaska. The Dolly Varden fed heavily on sockeye salmon fry when available, shifted their diet almost exclusively to eggs after salmon spawning commenced, and then shifted to blowfly larvae toward the end of the season. Dolly Varden large enough to eat eggs moved into ponds where sockeye salmon spawn synchronously with the arrival of the salmon, and Dolly Varden growth rates increased greatly once salmon eggs and blowfly maggots were available. Young-of-the-year Dolly Varden, which were too small to eat eggs and fry, were concentrated in small streams between ponds where fewer sockeye salmon spawn, perhaps to minimize the risk of predation from larger conspecifics. These results indicate the importance of a pulse of salmon-related food resources for this population of resident fish and their adaptations to take advantage of these resources. It is likely that similar dependence occurs in other systems where sockeye salmon produce a suite of temporally predictable energy resources; thus, resident fish may depend on large populations of salmon.

35-44	This paper provides an estimate of the economic value of wild salmon ecosystems in the major watershed of Bristol Bay, Alaska. The analysis utilizes both regional economic and social benefit-cost accounting frameworks. Key sectors analyzed include subsistence, commercial fishing, sport fishing, hunting, and nonconsumptive wildlife viewing and tourism. The mixed cash-subsistence economy of Bristol Bay supports a population of 7,611 (2000 census) that is 67 percent Alaska Native. Estimated expenditures and net economic values for all sectors were based on a literature review and available data, with the exception that original data was collected for 2005 on the sport fish sector using a random sample of licensed Alaska anglers. Methods included use of a regional input-output model maintained at the University of Alaska, and survey research and contingent valuation methods for the sport fishermen. Potential respondents included 886 resident anglers and 1,514 nonresident anglers contacted through a mail/internet approach. Additionally, 300 licensed anglers, 330 clients of Bristol Bay fishing lodges, and 46 lodge owners were contacted through a mail survey. Response rates ranged from 25.6 percent for resident anglers to 44.1 percent for nonresidents. Estimated direct expenditures/sales were $234.4 million in 2005 for commercial fishing and processing, $61 million for sport fishing, $17.1 million for wildlife viewing, $7.2 million for subsistence-related expenditures, and $12.4 million for sport hunting. Nearly 100 percent of the private basic sector in Bristol Bay and 5,540 full-time equivalent jobs are supported by this $324 million estimated direct economic impact associated with wild salmon ecosystem services. Direct net economic values are estimated at $104 million to $179 million per year, and are primarily associated with the subsistence sector.
51	This report summarizes sport fisheries addressed in Bristol Bay proposals to the Alaska Board of Fisheries during 2009. Fisheries include Nushagak-Mulchatna Chinook salmon (king) *Oncorhynchus tshawytscha*, and Brooks River and American Creek rainbow trout *O. mykiss*. The sport fisheries are described, and estimates of sport effort, catch, and harvest, and escapement are provided. Overviews of management for each fishery are provided, such as pertinent sport fishing regulations and management plans, including the Nushagak-Mulchatna King Salmon Management Plan and the Southwest Alaska Rainbow Trout Management Plan.
41(5): 1109-1115	The effects of climate warming on the thermal habitat of 57 species of fish of the U.S. were estimated using results for a doubling of atmospheric carbon dioxide that were predicted by the Canadian Climate Center general circulation model. Baseline water temperature conditions were calculated from data collected at 1,700 U.S. Geological Survey stream monitoring stations across the U.S. Water temperatures after predicted climate change were obtained by multiplying air temperature changes by 0.9, a factor based on several field studies, and adding them to baseline water temperatures at stations in corresponding grid cells. Results indicated that habitat for cold and cool water fish would be reduced by -5O%, and that this effect would be distributed throughout the existing range of these species. Habitat losses were greater among species with smaller initial distributions and in geographic regions with the greatest warming (e.g. the central Midwest). Results for warm water fish habitat were less certain because of the poor state of knowledge regarding their high and low temperature tolerances; however, the habitat of many species of this thermal guild likely will also be substantially reduced by climate warming, whereas the habitat of other species will be increased.

212	Ecological risk assessment (ERA) has become an essential tool for determining impacts to biological receptors as a result of contamination from metal mining facilities (Brumbaugh et al. 1994, Canfield et al. 1994, Ingersoll et al. 1994, Kemble et al. 1994, Pascoe and DalSoglio 1994, Pascoe et al. 1994, Linkov et al. 2002). The United States Environmental Protection Agency (EPA) Risk Assessment Forum developed the Framework for Metals Risk Assessment (2007a), which is a science-based document that addresses the special attributes and behaviors of metals and metal compounds to be considered when assessing their human health and ecological risks. To date, efforts have been designed to address the impacts or risks posed by metals contamination subsequent to mining operations. Few, if any, ERAs have been directed at pre-mining impacts. Smith (2007) provided strategies to predict metal mobility at mining sites through evaluation of source characterization, geoenvironmental models, geoavailability, and metals speciation; controlling physicochemical attributes (e.g., solubility, pH, sorption) in aqueous environments are discussed relative to their potential to alter metals bioavailability. The relevance of historical information on metals contamination associated with other mine sites, along with the potential for acid mine drainage (AMD) and metals release and exposure, based on review of the baseline data and geochemical characteristics at a site, have been used to develop both quantitative and qualitative predictions of risk. The present ERA is designed to analyze and portray the potential risks to globally significant salmon resources of the Nushagak-Mulchatna, and Kvichak river drainages (proximal headwater areas) as a result of large-scale mining and associated facilities. These risks include both physical destruction and alteration of salmon habitat, in addition to probable effects from changes to water chemistry and other supporting habitat as a result of AMD and the influx of metals within the aquatic ecosystem from various sources. Although the ERA generally presents impacts to salmon from loss of food resources such as benthic invertebrates, it does not focus on specific effects to these fauna. Similarly, although risks to non-anadromous fish within potentially affected stream segments may be similar to salmon, these taxa are not addressed individually within the ERA.
96: 343-366	The study examined two competing hypotheses seeking to explain the Kvichak cycle: (1) existence of a depensatory agent independent of the fishery and (2) depensatory fishing. The first hypothesis was implicit in the status quo harvest policy. Available data were analyzed to evaluate the alternative hypotheses. Little evidence for direct depensatory mortality independent of the fishery was found, however, production was depressed in brood years following large escapement brood years. In addition, the fishery itself was found to be extremely depensatory. A stochastic empirical computer simulation model incorporating processes found in the data analyses was used to examine the consistency of brood year interaction with the depensatory fishing hypothesis and historical cyclic patterns in the Kvichak run. The model predicted weak cyclic patterns in the unexploited run and strong cyclic patterns, consistent with the historical patern, in the run exploited under the status quo harvest policy of cyclic escapement goals. The model was then used to evaluate the alternative harvest policies. There were almost no differences in simulated catches under the status quo and static fixed escapement goal and static rate of exploitation policies. Substantial increases in simulated catch occurred with a dynamic policy of alternate years of high escapments following years of low escapement. This harvest policy can be phased with the cycle of resulting runs based on a forecast of future runs. The study suggested that the present Kvichak sockeye management policy should be altered by reducing the prepeak escapment goal and establishing a second peak cycle run.

10(2): 95-103	The Kvichak River of Bristol Bay, Alaska, is one of the world's largest sockeye salmon producing systems. This paper reviews and documents past management practices for the Kvichak River sockeye salmon. Fishery harvests are managed to meet a biological spawning escapement goal set by the State of Alaska and regulated using management plans adopted by the Alaska Board of Fisheries. Several measures of inseason run abundance are used to determine time and area of fishery openings that allow the escapement goal to be met and ensure that escapement is obtained throughout the run. Returns to the Kvichak River have been relatively small for seven of the past eight years. To hasten rebuilding of this run, the Alaska Board of Fisheries implemented additional management plans in 2001 that limit incidental harvests of Kvichak River sockeye salmon. These restrictions were effective in decreasing the catch of Kvichak River sockeye salmon, but total escapements achieved in 2002 and 2003 were still below the lower end of the escapement goals thought to produce the greatest catches in the future. While small runs and resulting low escapement levels have restricted commercial and sport fishery harvests, sustainability of this sockeye salmon run does not appear threatened at this time. The escapement goal for the Kvichak River is set at a level that provides the greatest potential for obtaining maximum sustained yield. While it is unlikely that escapements below the goal will provide high yields, past performance of low escapements has demonstrated that the Kvichak River run is still sustainable and has the capacity to produce large returns when conditions are favorable.
27(2): 68-92	Since 1980, the Division of Subsistence of the Alaska Department of Fish and Game has conducted research on contemporary hunting, fishing, and gathering in Alaska Native and other rural Alaska communities. This paper describes the division's research program and some the results of the division's studies. First, there is an overview of the state and federal legislation which provides a preference for subsistence uses in resource management and allocation decisions. Next, the division's research methods are discussed, followed by a summary of some of the recent findings about the role of subsistence uses in the mixed subsistence-based economies of Alaskan villages. A description of a "baseline" study in the Central Yup'ik Eskimo village of Manokotak illustrates the kinds of information which the division has collected for about 151 communities. The paper also illustrates how these data have been applied in resource management decisions. In conclusion, the paper speculates about the future of the program in light of court decisions which may eliminate the legal protections which have pertained to subsistence uses in Alaska since 1978.

405	This report presents updated information about subsistence uses of fish, wildlife, and plant resources in 5 communities of southcentral Alaska -- Iliamna, Newhalen, Nondalton, Pedro Bay, and Port Alsworth. The Division of Subsistence of the Alaska Department of Fish and Game conducted the study in collaboration with the National Park Service and Stephen R. Braund & Associates. The Pebble Project is a proposed open pit mine located 18 miles to the northwest of Iliamna and 18 miles southwest of Nondalton. The potential development of the mine requires updated baseline information about subsistence harvests and uses. Information was collected through systematic household surveys and mapping interviews. Scoping meetings were held in each community to elicit ideas about research questions and to learn more about issues. After preliminary study findings were available, a second round of community meetings took place to review the results. In total, 116 households were interviewed, 79% of the year-round resident households. The study documented the continuing importance of subsistence hunting, fishing, and gathering to the study communities. In 2004, virtually every person in each community participated in subsistence activities and used wild resources. Subsistence harvests were large and diverse. Estimated wild resource harvests were 469 pounds usable weight per person in Iliamna, 692 pounds per person in Newhalen, 358 pounds per person in Nondalton, 306 pounds per person in Pedro Bay, and 133 pounds per person in Port Alsworth. Most participants in this study reported their subsistence uses and harvests have changed in their lifetimes and over the last 5 years, due to reduced resource populations, shifts in the locations of moose and caribou, competition with nonlocal sport hunters, and a warming climate. Residents voiced concerns about the potential development of a mine and the construction of a road through and near their traditional subsistence harvest areas.
44	None

222	Each year thousands of Alaskans participate in subsistence activities including the harvest of wild resources from Alaska's fisheries. Subsistence fishing is an important element of Alaska's social and cultural heritage, as well as a crucial component of the subsistence sector of the state's economy. This report summarizes Alaska's 2007 subsistence fishing season based upon subsistence permit data and harvest assessment surveys from across the state. New information is compared to findings from previous years and the results are discussed. Where appropriate, harvest information from "personal use" fisheries is included. Additional information from federal agencies regulating and administering certain subsistence fisheries beginning in 1997 is included where available.
235	This final report presents the results of an ethnographic project that investigated how families in 4 communities of the Kvichak District of the Bristol Bay Management Area of Southwest Alaska develop subsistence fishing strategies, such as when to fish, where to fish, who to fish with, and how much to harvest, in response to changing sociocultural, economic, and environmental circumstances. Research methods included participant observation at fish camps, key respondent interviews, family case studies, and systematic household surveys. This report describes case examples of summer subsistence fishing for sockeye salmon *Oncorhynchus nerka*, examples of subsistence fishing in the fall for spawning sockeye salmon, and a review of the use of seine nets as a subsistence sockeye salmon fishing method at Nondalton. The report concludes that the subsistence fishery is vital to the way of life of the study communities, and is accomplished in an efficient and sustainable manner informed by traditional knowledge. Annual and long term variations in the fishery are shaped by a complex set of environmental, economic, cultural, and personal factors. Also, findings based on household surveys and permit returns suggest that relying solely on permit returns results in an underestimate of subsistence sockeye salmon harvests. Additional outreach is necessary to encourage households to obtain permits and keep accurate records of their harvests.
132: 450-467	Abandoned tailings and mine adits are located throughout the Boulder River watershed in Montana. In this watershed, all species of fish are absent from some tributary reaches near mine sources; however, populations of brook trout *Salvelinus fontitalis*, rainbow trout *Oncorhynchus mykiss*, and cut-throat trout *O. clarki* are found further downstream. Multiple methods must be used to investigate the effects of metals released by past mining activity because the effects on aquatic life may range in severity, depending on the proximity of mine sources. Therefore, we used three types of effects -- those on fish population levels (as measured by survival), those on biomass and density, and those at the level of the individual (as measured by increases in metallothionein, products of lipid peroxidation, and increases in concentrations of tissue metals) -- to assess the aquatic health of the Boulder River watershed. Elevated concentrations of Cd, Cu, and Zn in the water column were associated with increased mortality of trout at sites located near mine waste sources. The hypertrophy (swelling), degeneration (dying), and necrosis of epithelial cells observed in the gills support our conclusion that the cause of death was related to metals in the water column. At a site further downstream (lower Cataract Creek), we observed impaired health of resident trout, as well as effects on biomass and density (measured as decreases in the kilograms of trout per hectare and the number per 300 m) and effects at the individual level, including increases in metallothionein, products of lipid peroxidation, and tissue concentrations of metals.

124	None
52(10): 917-928	Because of the burgeoning interest in salmon, growing indications of their ecological importance, and recent calls for management to consider the role of salmon in aquatic and terrestrial ecosystems (e.g., Larkin and Slaney 1997), we take this opportunity to review what is understood about the function of salmon as key elements of ecological systems. Our objectives are twofold. First, we expand on previous reviews of salmon (Willson et al. 1998, Cederholm et al. 1999) to include recent research that has amplified and modified earlier ideas about the contribution of salmon to ecosystem processes. In doing so, we describe the composition, magnitude, and distribution of marine inputs to freshwater and terrestrial systems via salmon. We use an expanding group of studies pertaining to stream nutrient budgets and salmon physiology to construct a schematic that illustrates salmon-derived products and the pathways by which they enter and are retained in aquatic and terrestrial food webs. We then consider the ecological variation associated with salmonid ecosystems and how this may influence the ecological response to the salmon input. Second, we consider how this variation in ecosystem response may influence management and conservation efforts. We conclude by suggesting new research directions to help fill the gaps in our current understanding of salmonid ecosystems.
39: 39-50	None

128: 121-129	Spawning migration of adult male chinook salmon *Oncorhynchus tshawytscha* was monitored by radio telemetry to determine their response to the presence of metals contamination in the South Fork of the Coeur d'Alene River, Idaho. The North Fork of the Coeur d'Alene River is relatively free of metals contamination and was used as a control. In all, 45 chinook salmon were transported from their natal stream, Wolf Lodge Creek, tagged with radio transmitters, and released in the Coeur d'Alene River 2 km downstream of the confluence of the South Fork and the North Fork of the Coeur d'Alene River. Fixed telemetry receivers were used to monitor the upstream movement of the tagged chinook salmon through the confluence area for 3 weeks after release. During this period, general water quality and metals concentrations were monitored in the study area. Of the 23 chinook salmon observed to move upstream from the release site and through the confluence area, the majority (16 fish, 70%) moved up the North Fork, and only 7 fish (30%) moved up the South Fork, where greater metals concentrations were observed. Our results agree with laboratory findings and suggest that natural fish populations will avoid tributaries with high metals contamination.
69: 379-393	Pacific salmon *Oncorhynchus* spp. play a central role in coastal ecosystems that rim the North Pacific Ocean. Given the ecological, cultural, and economic importance of Pacific salmon, there is great interest in defining the magnitude and frequency of change in these fish stocks. Fisheries scientists, through analyzing harvest records, have demonstrated pronounced salmon production variability. The causes underlying such marked fluctuations are currently debated. Collating harvest records across a broad geographic range over the past ~80 years, fisheries scientists have advanced a plausible argument that climate-induced oceanographic changes explain a significant fraction of the variation in salmon catch records. However, without data that predate the introduction of large-scale human interventions (e.g., commercial harvesting, dams, hatchery releases), it is difficult to isolate the role of climate in shaping fish stock dynamics. Within the past decade, however, we have developed a paleolimnological approach for tracking past sockeye salmon *Oncorhynchus nerka* population abundances, and numerous papers have applied this approach to infer changes in these fish over the past hundreds to thousands of years. Here, we provide an overview of the approach and a synthesis of the work that has been conducted in this field to date. It is clear that numerous sockeye salmon populations have undergone pronounced changes, even prior to human interventions. Furthermore, tracking salmon populations over millennial timescales with paleolimnology has revealed modes of change that were previously never imagined possible. Such long-term perspectives indicate that sockeye salmon is a resilient fish species. We note, however, that when natural environmental changes are compounded by intense human impacts, populations have been particularly susceptible to extirpation.
25(1): 15-21	We used historical cannery records and current escapement and harvest records to estimate historical and current salmon escapement to western North American river systems, in order to determine the biomass and marine-derived nitrogen and phosphorous levels delivered by adult salmon, and the deficits corresponding to the diminished returns of adult salmon over the past century. We have estimated the historic biomass of salmon returning to the Pacific Northwest (Washington, Oregon, Idaho, and California) to be 160-226 million kg. The number of fish now returning to these rivers has a biomass of 11.8-13.7 million kg. These numbers indicate that just 6-7% of the marine-derived nitrogen and phosphorous once delivered to the rivers of the Pacific Northwest is currently reaching those streams. This nutrient deficit may be one indication of ecosystem failure that has contributed to the downward spiral of salmonid abundance and diversity in general, further diminishing the possibility of salmon population recovery to self-sustaining levels.

564	Pacific salmon are an important biological and economic resource of countries of the North Pacific rim. They are also a unique group of fish possessing unusually complex life histories. There are seven species of Pacific salmon, five occuring on both the North American and Asian continents (sockeye, pink, chum, Chinook, and coho) and two (masu and amago) only in Asia. The life cycle of the Pacific salmon begins in the autumn when the adult female deposits eggs that are fertilized in gravel beds in rivers or lakes. The young emerge from the gravel the following spring and will either migrate immediately to salt water or spend one or more years in a river or lake before migrating. Migrations in the ocean are extensive during the feeding and growing phase, covering thousands of kilometres. After one or more years the maturing adults find their way back to their home river, returning to their ancestral breeding grounds to spawn. They die after spawning, and the eggs in the gravel signify the beginning of a new cycle. Upon this theme Pacific salmon have developed many variations, both between as well as within species. Pacific Salmon Life Histories provides detailed descriptions of the different life phases through which each of the seven species passes. Each chapter is written by a scientist who has spent years studying and observing a particular species of salmon. Some of the topics covered are geographic distribution, transplants, freshwater life, ocean life, development, growth, feeding, diet, migration, and spawning behaviour. The text is richly supplemented by numerous maps, illustrations, colour plates, and tables and there is a detailed general index, as well as a useful geographical index. This volume brings together for the first time, and in a comprehensive form, most of the available biological information on the seven species of Pacific salmon. It is an invaluable source of information for students and teachers of biology and fisheries science, people in the fishing and aquaculture industry, and interested laypersons in countries of the North Pacific and elsewhere.
136(1): 82-94	We examined the population genetic diversity and structure of sockeye salmon *Oncorhynchus nerka* spawning in tributaries of Bristol Bay, Alaska, a region that supports the largest commercial fisheries for sockeye salmon in the world. Genetic variation among the sockeye salmon populations, as revealed by microsatellite data, was shallower than that found in other areas of comparable size around the Pacific Rim. This finding was driven by similarity among populations rearing in the four largest lake systems located on the southeastern side of the bay (upper and lower Ugashik, Becharof, Naknek-Grosvenor-Coville, and Iliamna lakes). Sockeye salmon in lakes located above known obstacles to migration on the southeastern side and in tributaries on the northwestern side showed variation and structure that were more typical of the species. Management of these important fisheries assumes knowledge of the composition of stock mixtures captured in each fishery. We investigated the potential of microsatellite data to provide stock composition estimates. We examined 58 collections and identified eight genetically discrete reporting groups. These reporting groups give fishery managers the opportunity to quantify stock components within fishing districts and thereby improve management precision.

450	Sport anglers reeling in salmon, halibut, and other fish generated--both directly and indirectly--an estimated three percent of jobs and payroll in Alaska in 1993. This is one of the findings of a study of the economics of sport fishing that ISER did for the Alaska Department of Fish and Game. Sport fishing is enormously popular with residents and visitors. The Department of Fish and Game estimates that nearly half a million anglers fished in Alaska in 1997, with numbers of visiting anglers slightly edging Alaskan anglers. Seven out of ten Alaska households have at least one sport angler. Nearly half of Alaska's households rate hunting and fishing opportunities as important reasons why they live where they do. The department contracted with ISER to do this study because the economics of sport fishing in Alaska is an important consideration for resource managers allocating fish stocks, evaluating fishery projects, and making decisions about land and water management. The analysis is based largely on information we collected in surveys of sport anglers and guide and charter businesses in 1993 and 1994. It's not entirely clear how sport fishing has changed since 1993. The Department of Fish and Game reports that the number of resident licenses stayed roughly the same, while the number issued to nonresidents grew about 25 percent. But at the same time, the department also reports that measures of fishing pressure-angler-days fished and numbers of fishing trips--have not changed substantially since 1993. There is some evidence that the growing number of visiting anglers may be mostly casual anglers, who fish once or twice while they're in Alaska. Numbers of sport charters operating in Southcentral and Southeast Alaska increased sharply in the 1990s, and many customers of those charters are tourists who buy single-day licenses. So the overall economic contribution of sport fishing may not have changed substantially since our survey. In any case, patterns of sport fishing--what people buy for sport fishing and how they travel to sport fishing locations, for instance--don't change quickly. We believe the broad picture of the economics of sport fishing in Alaska that we present here is valid. Below we first describe how we assessed the economics of sport fishing, then profile resident and visiting sport anglers, and conclude with our estimates of the economic value of sport fishing and its contribution to the economy.
18(9): 1972-1978	Behavioral avoidance of copper (Cu), cobalt (Co), and a Cu and Co mixture in soft water differed greatly between rainbow trout (*Oncorhynchus mykiss*) and chinook salmon (*O. tshawytscha*). Chinook salmon avoided at least 0.7µ * Cu/L, 24 µ* Co/L, and the mixture of 1.0 *g Cu/L and 0.9 *g Co/L, whereas rainbow trout avoided at least 1.6 *g Cu/L, 180 *g Co/L, and the mixture of 2.6 µ* Cu/L and 2.4 µ* Co/L. Chinook salmon were also more sensitive to the toxic effects of Cu in that they failed to avoid *4 *g Cu/L, whereas rainbow trout failed to avoid *80 *g Cu/L. Furthermore, following acclimation to 2 _xFFFF_µg Cu/L, rainbow trout avoided 4 *g Cu/L and preferred clean water, but chinook salmon failed to avoid any Cu concentrations and did not prefer clean water. The failure to avoid high concentrations of metals by both species suggests that the sensory mechanism responsible for avoidance responses was impaired. Exposure to Cu concentrations that were not avoided could result in lethality from prolonged Cu exposure or in impairment of sensory-dependent behaviors that are essential for survival and reproduction.

20	The freshwater streams of the Bristol Bay drainages support important subsistence and commercial salmon fisheries and internationally-famous sport fisheries for both resident species and salmon. Northern Dynasty Mines, Inc. (NDM) has proposed to mine a metallic sulfide deposit at the headwaters of some of these streams. The project, referred to as Pebble Mine, will have a preliminary lifespan of 40 to 50 years, or even longer. Applications filed by NDM in 2006 indicate that the proposed project will leave permanent landscape features affecting some thirty square miles, including two tailings ponds that will house billions of tons of mine tailings which will include toxic materials. The project will also include a 104-mile access road, with a slurry line and a water line that will directly affect at least 12.5 square miles and a power transmission line. The 2006 applications help identify potential impacts on the fish habitat and fisheries. Categories of these potential impacts of Pebble Mine on fish habitat and fishery resources include: direct, indirect, and cumulative effects. Direct impacts will result from the approximately 30 square mile footprint of the mine, processing plant, and tailings ponds; more than 60 lineal miles of mainstem streams--plus the adjacent tributaries and wetlands--that will be totally or partially dewatered; the 12.5 square miles or 8,000 acres of disturbance from the access road; port facilities; and, power production and power supply lines. Siltation caused by road-building activities will smother fish food organisms and incubating eggs and alevins. Direct effects associated with the road also include fragmentation of aquatic, riparian, and terrestrial habitats. Indirect impacts will include increased pressure on, and competition for, fish and wildlife resources, because of the increased access to the area and increased population. Cumulative impacts will include long-term, multi-year losses of fish production and stream productivity. Over time, bridges and culverts in the access road can deteriorate and interfere with juvenile or adult fish migration between important habitats. Dust and silt from the road during the life of the project or leakage from the slurry line may smother fish food organisms and incubating fish eggs and could wash downstream to affect spawning and rearing habitat in Iliamna Lake. In addition, the weight of the roadbed and traffic can be expected to compact the soil and alter the movement of groundwater which could disrupt beach spawning by sockeye salmon in Iliamna Lake. Although the access road and other support roads will be constructed for the proposed Pebble Mine, they will also provide access to the area by other residential, commercial, and recreational users. The human population and activities can be expected to increase, and off road, all terrain vehicle use will expand into areas not previously accessible. The impact will extend much beyond the footprint of the road itself. Any real or perceived impact from the proposed Pebble Mine on Bristol Bay salmon populations will have the probability of destroying the high-
34(3): 303-309	This study assessed the summer diet and consumption patterns of harbor seals (*Phoca vitulina*) resident in Iliamna Lake, Alaska. The authors predicted that adult sockeye salmon (*Oncorhynchus nerka*), a seasonally abundant and nutrient-rich prey source, would dominate diets when available and that seals would preferentially consume the most energetically profitable portion of salmon carcasses. Diet was examined by identifying hard parts of prey found in harbor seal scats, and consumption patterns were measured by collecting carcasses of harbor seal-killed sockeye salmon along island spawning grounds. Salmonids were present in 98% of scats that contained identifiable prey, followed by petromyzontids, osmerids, cottids, coregonids, and gasterosterids. The carcass surveys provided evidence of selective consumption patterns of sockeye salmon body parts. Harbor seals consumed the bodies of nearly all (96.6%) male salmon collected, leaving little but the head. In contrast, the belly and eggs were consumed in 63.6% of the female samples, and the entire body was eaten in only 31.3% of females. The harbor seals in Iliamna Lake thus took advantage of the seasonally abundant adult sockeye salmon by consuming them selectively and as a high proportion of their diet, but they also consumed smaller resident fishes, which presumably sustain them during the rest of the year.

100(11): 6564-6568	A classic example of a sustainable fishery is that targeting sockeye salmon in Bristol Bay, Alaska, where record catches have occurred during the last 20 years. The stock complex is an amalgamation of several hundred discrete spawning populations. Structured within lake systems, individual populations display diverse life history characteristics and local adaptations to the variation in spawning and rearing habitats. This biocomplexity has enabled the aggregate of populations to sustain its productivity despite major changes in climatic conditions affecting the freshwater and marine environments during the last century. Different geographic and life history components that were minor producers during one climatic regime have dominated during others, emphasizing that the biocomplexity of fish stocks is critical for maintaining their resilience to environmental change.
100(11): 487-498	Many of Alaska's salmon fisheries are models of biological success, with management structures that have maintained biomass, stock diversity, and biological yield. At the same time the fisheries face severe challenges due to low product price, and have been declared formal "economic" disasters by state and federal agencies in recent years. From many perspectives, these fisheries are in crisis. I explore how the governance system for Alaska's Bristol Bay fishery has led to biological success and economic failure. I review a range of alternative governance structures, in place or being considered, that might provide for social and economic sustainability. I also demonstrate that the basic biological principal that has guided management, maximum sustainable yield, is a serious impediment to social and economic sustainability.
121(4): 546-550	We quantified the amount, spatial distribution, and importance of salmon *(Oncorhynchus* sp.)-derived nitrogen (N) by brown bears (*Ursus arctos*) on the Kenai Peninsula, Alaska. We tested and confirmed the hypothesis that the stable isotope signature ($\delta 15N$) of N in foliage of white spruce (*Picea glauca*) was inversely proportional to the distance from salmon-spawning streams ($r=-0.99$ and $P<0.05$ in two separate watersheds). Locations of radio-collared brown bears, relative to their distance from a stream, were highly correlated with $\delta 15N$ depletion of foliage across the same gradient ($r=-0.98$ and -0.96 and $P<0.05$ in the same two separate watersheds). Mean rates of redistribution of salmon-derived N by adult female brown bears were 37.2 ± 2.9 kg/year per bear (range 23.1-56.3), of which 96% (35.7 ± 2.7 kg/year per bear) was excreted in urine, 3% (1.1 ± 0.1 kg/year per bear) was excreted in feces, and <1% (0.3 ± 0.1 kg/year per bear) was retained in the body. On an area basis, salmon-N redistribution rates were as high as 5.1 ± 0.7 mg/sq.-m per year per bear within 500 m of the stream but dropped off greatly with increasing distance. We estimated that 15.5-17.8% of the total N in spruce foliage within 500 m of the stream was derived from salmon. Of that, bears had distributed 83-84%. Thus, brown bears can be an important vector of salmon-derived N into riparian ecosystems, but their effects are highly variable spatially and a function of bear density.

32	State-owned lands on the Bristol Bay coastal plain in southwest Alaska have been opened for oil and gas exploration. This area encompasses numerous small lakes and ponds on the Nushagak and Alaska peninsulas. To date, there have been few data collected describing the fish species or subsistence use of the small tundra ponds in the region. During 2006, a pilot project was completed to sample fish communities in selected small tundra ponds near King Salmon, Alaska. Nineteen ponds were surveyed during early summer, and fish were found in all ponds with depths greater than 0.9 m. Alaska blackfish *Dallia pectoralis* were the most abundant and wide-spread species encountered and were found in all but one pond where fish were present. Ninespine stickleback *Pungitius pungitius* were captured in five ponds and threespine stickleback *Gasterosteus aculeatus* were captured in four ponds. Northern pike *Esox lucius*, longnose sucker *Catostomus catostomus*, and pond smelt *Hypomesus olidus* were also encountered, but each species was only found in single ponds. Our sampling methods may not have been sufficient to capture all species present. The most productive sampling gears were multifilament experimental gillnets and baited minnow traps. Our sampling during 2006 suggested that, for the tundra ponds we examined, those that do not experience winterkill should support fish populations even though all of the ponds we surveyed were small (< 0.5 sq.-km), shallow (< 2.5 m), and had no temporally continuous outlets connecting them to streams. Future work should provide an inventory of the size and number of tundra ponds in areas of interest and representatively sample those ponds, including larger, deeper ponds that may be providing rearing habitat for anadromous fish. With this data, researchers could potentially develop a model for predicting fish presence or absence in these ponds. The model could be used to assess impacts from potential resource development and to guide resource development away from inhabited areas or to determine other mitigation options during the resource planning and development process.
77(2): 395-407	We manipulated, in accord with global-warming predictions, the thermal regime of a permanent first-order stream near Toronto, Ontario, Canada. We examined the effects of a 2-3.5°C water-temperature increase on densities, biomass, species composition, and life histories of resident stream invertebrates. The stream was divided longitudinally at the source into two channels, one control and one experimental, and a before and after (BACI) design was employed such that one pre-manipulation year was followed by 2 yr of the temperature manipulation. Changes in the experimental channel following commencement of the manipulation included: (1) decreased total animal densities, particularly Chironomidae (Diptera); (2) earlier onset of adult insect emergence; (3) increased growth rates and precocious breeding in *Hyalella azteca* (Amphipoda); (4) smaller size at maturity for *Nemoura trispinosa* (Plecoptera) and *H. azteca*; and (5) altered sex ratios for *Lepidostoma vernale* (Trichoptera). These results partially corroborate previous laboratory and field studies. However, variation in the responses of individual target species to the manipulation was unexpected and may have been influenced by the genetic structure of local populations. We conclude that levels of gene flow among habitats may be critical to the degree of impact seen as a result of large-scale thermal perturbation (e.g., global warming).

113(1): 81-101	Many explanations for diversity patterns have been proposed, and there have been several recent reviews of the subject (Pianka 1966, 1974; Ricklefs 1973; Pielou 1975). High diversity has been attributed both to intense competition which forces niche restriction (Dobzhansky 1950; MacArthur and Wilson 1967) and negatively correlated with productivity (Yount 1956; Margalef 1969). The question is far from settled. This paper develops an approach to the problem of species diversity based on the nonequilibrium interactions of competing populations. Under nonequilibrium conditions, differences in diversity are strongly influenced by variations in the rates of competitive displacement between communities, and such factors as relative competititve abilities, niche partitioning, etc., may not be particularly important. This approach deals primarily with the maintenance of diversity, as opposed to the generation of diversity. While most of the current diversity hypotheses have some relation to the evolutionary origin of diversity, this will not be emphasized here.
93(870): 145-159	None
19: 1-15	None
17	Limited entry permit holdings, fishery harvests, and estimated gross earnings are broken out by resident type for the Bristol Bay salmon drift gillnet and set gillnet fisheries. Three resident types are considered: persons who reside in places local to Bristol Bay; persons who reside in Alaska, but in places outside of Bristol Bay; and persons who are nonresidents of Alaska. The resident status for a permit is determined by the residence of the end-of-the year permit holder. This report also contains a description of the computer files and methodology used to generate the figures.

10	As long linear ecosystems, rivers and streams are particularly vulnerable to fragmentation. There is growing concern about the role of road crossings – and especially culverts – in altering habitats and disrupting river and stream continuity. Most of the culverts currently in place were designed with the principal objective of moving water across a road alignment. Little consideration was given to ecosystem processes such as the natural hydrology, sediment transport, fish and wildlife passage, or the movement of woody debris. It is not surprising then that many culverts significantly disrupt the movement of aquatic organisms. Survival of individual animals, facilitation of reproduction, and the maintenance of population continuity are important functions of movement at a population level. Dispersal of individuals provides a mechanism for regulating population density. These dispersing individuals maintain gene flow among populations and may supplement populations where recruitment is unable to keep pace with the loss of individuals. For many small species (especially invertebrates), dispersal of individuals provides a mechanism for colonizing habitat, allowing local populations to come and go as habitat is created or eliminated, while maintaining viable regional populations. Much attention has been focused on passage for migratory fish, especially in the northwestern U.S. In some cases, considerable resources have been invested in projects addressing fish passage only to find that accommodations made for adults did not address the needs of juvenile fish. Long-term conservation of fish resources will depend not only on passage for both adult and juvenile fish but also on maintenance of healthy stream and river ecosystems. Essential to this approach is a focus on habitat quality and strategies for aquatic organism passage based on communities rather than individual species. Without an ecosystem-based approach to river and stream crossings we will be at risk of facilitating passage for particular fish species while at the same time undermining the ecological integrity of the ecosystems on which these fish depend. Stream simulation is an approach to culvert design that both avoids flow constriction during normal conditions and creates a stream channel within culverts that resists scouring during flood events. Designing culverts to avoid channel constriction and to maintain appropriate channel conditions within the structure is a relatively simple and effective approach for accommodating the normal movements of aquatic organisms and preserving (or restoring) many ecosystem processes that maintain habitats and aquatic animal populations. Road networks and river systems share several things in common. Both are long, linear features of the landscape. Transporting materials (and organisms) is fundamental to how they function. Connectivity is key to the continued functioning of both systems. Ultimately, our goal should be to create a transportation infrastructure that does not fragment or undermine the essential ecological infrastructure of the land
238	Since 1977, the Alaska Department of Fish and Game has conducted an annual mail survey to estimate sportfishing participation and harvests (fish kept) statewide by Alaskan fisheries, areas, regions, and species. Since 1990, catches (fish and clams harvested plus fish released) have also been estimated. Detailed findings are presented for 2001. In 2001, an estimated 432,129 anglers fished 2,261,941 days and kept 3,078,100 of the 6,775,786 fish and clams caught. The 3,216,432 fish harvested in 2002 included 788,665 razor clams *Siliqua patula* and 96,304 smelt and capelin Osmeridae. Of the remaining 2,331,463 harvested fish, 1,523,338 (65.3%) were anadromous (sea-run) salmon *Oncorhynchus*, 350,809 (15.1%) were Pacific halibut *Hippoglossus stenolepis*, 120,398 (5.2%) were rockfish Sebastes, 117,063 (5.0%) were rainbow trout *O. mykiss*, 60,994 (2.6%) were Dolly Varden *Salvelinus malma* and Arctic char *Salvelinus alpinus*, 37,910 (1.6%) were Arctic grayling *Thymallus arcticus*, and 38,498 (1.7%) were landlocked salmon (Chinook salmon, coho salmon *O. kisutch*, and kokanee *O. nerka*).

307	None
130: 1106-1115	Much research has been devoted to the effects of acidic runoff episodes on populations of brook trout *Salvelinus fontinalis*. Less is known about slimy sculpin *Cottus cognatus* and why their numbers have declined in acidified streams. Adult tolerance of low pH and aluminum (Al) toxicity is similar in these two species. Slimy sculpin spawn in the spring, when high stream flows elevate concentrations of toxic Al and decrease stream pH in acid-sensitive watersheds. We hypothesized that acidic episodes in spring were a source of stress for slimy sculpin and hindered their reproduction. We tested this hypothesis by examining the mortality, behavior, whole-body sodium concentrations, and spawning among slimy sculpin exposed to ambient conditions during the spring spawning period in two Pennsylvania streams, Stone Run (an episodically acidified stream that formerly contained slimy sculpin) and Benner Run (a stream with slimy sculpin that does not experience severe acidic episodes). Our hypothesis was supported by the higher mortality, hypoactivity, lower body sodium concentrations, and lack of spawning among slimy sculpin in Stone Run relative to those in Benner Run. Reproductive disturbance caused by stressful concen- trations of Al and hydrogen ions may have led to the recruitment failure and collapse of the slimy sculpin population in Stone Run.
22(4): 429-440	Little is known of how fish respond to the hydraulic environment associated with diversion or bypass structures at hydroelectric power installations. To address this lack of knowledge, this paper presents results from a study to assess how three species of Pacific salmonid smolt (*Oncorhynchus* spp.) responded to distinct gradients of velocity and depth associated with two submerged weirs as they passed through an experimental flume at McNary Dam (Columbia River, USA) under illuminated and dark conditions. Migrating smolts entered one of two available treatment channels as coherent schools from which individuals would either disassociate from the group and pass over the weirs, or would reject them by swimming upstream. Alternatively, fish maintained position at the upstream end of the flume by swimming into the flow. The response of smolts to velocity and depth gradient and light condition varied between species, and route of passage was influenced by fork length. Initial channel selection and school size was not influenced by weir type, although schools resided longer within the short-weir channel. The majority of smolts (70%) entered the treatment channels facing downstream (negative rheotaxis), but switched orientation at the crests of the weirs. This switch in orientation occurred farther downstream in the short-weir treatment and for the largest smolts. The variation in response of different species of smolts to hydraulic gradients has important implications for the design of screening mechanisms used at hydroelectric power installations to divert migrant juvenile salmonids.

55: 2339-2346	1. Warming trends are evident in many parts of the globe but are especially marked at higher latitudes, with complex effects on the biota that include direct effects on growth potential and indirect effects through food webs; 2. Air temperatures have been increasing over the past 50 years in southwestern Alaska, affecting the growth and population dynamics of many organisms, including a variety of aquatic species such as the freshwater mussel *Anodonta beringiana*; 3. We collected freshwater mussels from Iliamna Lake, in the Bristol Bay region of Alaska, and measured their shells to examine climatic effects on growth patterns; 4. Linear mixed effects models and ordinary least square linear regressions revealed strong positive correlations between local air temperatures (especially in May, October and the summer months) and inter-annual variation in mussel growth. Slower mussel growth was also significantly correlated with later date of ice break-up, which was linked to air temperatures in late spring.
50: 2350-2365	Biota δ15N and δ13C values (deviations from recognized isotope standards) from Iliamna Lake (a major anadromous sockeye salmon (*Oncorhynchus nerka*) nursery lake supporting peak-year runs >10 million) and several other anadromous-salmon-free lakes in the Kvichak River watershed, Bristol Bay, southwestern Alaska, were compared to determine the significance of marine-derived nitrogen (MDN) delivered by returning adult salmon. Biota in Iliamna Lake had higher δ15N compared with control lakes, verifying a mixing model correlating δ15N with MDN. Periphyton δ15N values reflected localized input from populations of spawning salmon. Juvenile sockeye MDN varied in response to escapement size, suggesting the importance of large escapements (>10 million) for maintaining a predominantly MDN lacustrine N pool. Other resident fishes showed shifts in δ15N between years of high and low escapement. The dual-isotope approach, using δ15N and δ13C together, suggested that fish production is primarily dependent on limnetic primary and secondary production. The dual-isotope approach indicated that the coast range sculpin (*Cottus aleuticus*) was the only fish with an appreciable dietary component consisting of salmon eggs or emergent fry.
170	The Commercial Fisheries Entry Commission (CFEC) requested this study for help in forecasting future ex-vessel prices of Bristol Bay sockeye salmon. CFEC plans to use the forecasts in analyzing the "optimum number" of limited entry permits in the Bristol Bay drift gillnet salmon fishery. The study describes markets for Bristol Bay sockeye salmon products and how market conditions affect ex-vessel prices. The study develops an equation for forecasting future sockeye salmon ex-vessel prices based on assumptions about future Bristol Bay harvests and future farmed salmon wholesale prices. This equation is used to forecast a range within which future sockeye salmon ex-vessel prices are likely to fall.
721	Sustainable Fisheries Management: Pacific Salmon clearly articulates the current state of the Pacific Salmon resource, describes the key features of its management, and provides important ideas and suggestions on how we can make the transition toward sustainable fisheries. The solutions presented in this book provide the basis of a strategy for sustainable fisheries, requiring society and government agencies to establish a shared vision, common policies, and a process for collaborative management.

253	The project collected information about subsistence harvests of nonsalmon freshwater fish by residents of the eight communities of the Kvichak River watershed of the Bristol Bay area, southwest Alaska, for a 12-month period from October 2002 through September 2003. Local research assistants were hired and trained to collect harvest calendars from participating households and conduct a post-season harvest survey. Data were collected on amounts harvested, gear types used, timing of harvests, and location of harvests. There was a high level of involvement in the subsistence use of nonsalmon fish in the study communities, although harvests were low compared to previous estimates from the 1970s, 1980s, and 1990s, primarily because the unusually warm winter in 2002/2003 inhibited travel and the use of traditional methods such as ice fishing. Also, TEK interviews were conducted with 28 individuals, covering such topics as population trends, fish ecology, and traditional harvest methods. These interviews were transcribed and incorporated into a searchable database using the askSam program.
228	None
43(8): 1488-1496	Juvenile rainbow trout were exposed to 25-400 µg copper□L^{-1} for 24h. Water hardness, pH, and alkalinity were varied independently at a constant [Na^+]. Net and unidirectional sodium fluxes were measured in hard and soft, low-alkalinity water and in hard, high-alkalinity water at neutral pH and pH 5.0. In low alkalinity water, Na^+ uptake (J_{in}) was inhibited at copper concentrations as low as 25 µg□L^{-1}, and sodium efflux (J_{out}) was stimulated above 100 µg□L^{-1}. High-alkalinity water significantly reduced the effects of copper on J_{in} and J_{out} but there was no significant effect of increasing water hardness. The effects of pH 5.0 and copper were additive from 25 to 100 µg□L^{-1}, but a pure copper effect was found from 200 to 400 µg□L^{-1}. Fish died when they had lost about 50-55% of their exchangeable Na+ pool. Water hardness and alkalinity had no effect on the apparent uptake of copper, but copper uptake was reduced by about 50% at pH 5.0.

222-251	The most comprehensive "insiders" guide on Alaska fishing, revised, updated, and expanded in this new deluxe, full color 3rd edition. Written by the state's top fishing experts, this latest version now covers all 17 major Alaska sport species (fresh and salt waters), all methods (fly, spin, and bait), and all six regions of the state, with details on over 300 of the most productive Alaska fishing locations. Includes information on regional climate/conditions, run timing, visitor service costs, trophy and record fishes, USGS map references, guides' tips, fishing regulations, etc. Bonus back section with Alaska trip planner, flies for Alaska, knots, fish filleting, and a comprehensive cross-referenced index. Has over 500 color photos, maps, charts, diagrams, and drawings. Beautifully illustrated, Alaska Fishing III offers a visual feast of this scenic wonderland, with content that not only thoroughly informs, but also captures the imagination and heart of the reader.
23(4): 399-417	Recent progress in the study of aquatic food-cycle relationships invites a re- appraisal of certain ecological tenets. Quantitative productivity data provide a basis for enunciating certain trophic principles, which, when applied to a series of successional stages, shed new light on the dynamics of ecological succession.
33(10): 2415-2423	We analysed the benthic macroinvertebrate species composition, taxonomic richness (as expected richness for 100 individuals), total abundance and biomass at 117 stream sites in the province of Dalarna. Partial least squares regression models were constructed from observations on undisturbed sites and used to predict these community parameters at sites exposed to elevated levels of copper, zinc, lead and cadmium resulting from leakage from old mine deposits. Species richness at undisturbed sites was positively related to the size of the catchment, pH, channel width, calcium concentration and the proportion of deciduous trees in the riparian zone. In streams with elevated metal concentrations, we found reductions in taxonomic richness for total macroinvertebrates, mayflies, stoneflies and combined EPT (Ephemeroptera, Plecoptera and Trichoptera), but not for that of Tri-choptera nor total abundance or biomass. Copper and zinc were those metals showing strongest negative associations with richness. Some taxa, common at undisturbed sites, were missing at metal-polluted sites. These taxa were the mayflies *Ameletus inopinatus*, *Ephemerella aurivilli* and *Heptagenia* dalecarlica, the stonefly *Protonemura meyeri* and the caddisfly *Apatania* sp.

29: 355-358	A half-century after mine closure, metal contamination from sulfide ore mining in the headwaters continues to impair riparian vegetation and aquatic macroinvertebrates along Soda Butte Creek, Yellowstone National Park. A tailings dam failure in 1950 emplaced metal-rich sediment at high flood-plain levels, above 50 yr to 100 yr flood stages in 1996 and 1997. These large natural floods removed only a small part of the contaminated sediment through bank erosion; they also failed to lower in-channel Cu concentrations, because increased erosion of mine waste during high flows balances increased inputs of uncontaminated sediments, generating no net change in concentrations. Geomorphic processes controlling movement of contaminated sediments indicate that mine impacts will persist for centuries in Soda Butte Creek and imply long-lasting impacts in similarly affected streams worldwide.
17	In compliance with the reporting requirements associated with Fish Resource Permit No. SF-2004-114 and amendment No. SF2004-114-A-1. This report summarizes the fish sampling efforts conducted within the Pebble Gold Copper project area and along the proposed road corridor by biologists from HDR Alaska, Inc. and Northern Ecological Services. Sampling was conducted between April and October 2004. The main purpose of the study was to document the distribution, relative abundance, and variety of fish species within the Pebble Gold Copper project area.
29	The habitat use information and Habitat Suitability Index (HSI) models presented in this document are intended for use in impact assessment and habitat management activities. Literature concerning a species, habitat requirements and preferences is reviewed and then synthesized into subjective HSI models, which are scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat). Assumptions used to transform habitat use information into these mathematical models are noted and guidelines for model application are described. Any models found in the literature which may also be used to calculate an HSI are cited. A section presenting Instream Flow Incremental Methodology (IFIM) will be included in this series in the near future.
54	Methodology (IFIM) will be included in this series in the near future. The IFIM section will include a discussion of Suitability Index (SI) curves, as are used in IFIM and a discussion of SI curves available for the IFIM analysis of coho salmon habitat.
145	Data contained in this report represent the Division's most recent efforts to upgrade and update fishery statistics useful in describing Southwestern Alaska's sport fisheries. Data contained in this document were extracted from Statewide Harvest Summaries, Survey and Inventory Reports, and the Fishery Data and Manuscript Series. We consider this report to be the most comprehensive information source concerning effort and harvest statistics for the major Southwestern Alaska sport fisheries. Fisheries data in this report supersede information in previous reports and are intended for interdepartmental use only.

140	In response to the guidelines established in the Sustainable Salmon Fisheries Policy (ADF&G 2000), the Alaska Department of Fish and Game (department) first classified the Kvichak River sockeye salmon *Oncorhynchus nerka* stock as a "Stock of Yield Concern" in 2001 (Bristol Bay Staff 2000). A yield concern is defined as "a concern arising from a chronic inability, despite use of specific management measures, to maintain expected yields." Classification of Kvichak River sockeye salmon was subsequently changed to a "Stock of Management Concern" in 2003. This classification change was based on the definition of "management concern" found in the policy. A "management concern" is defined as, "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for salmon stocks within the bounds of Sustainable Escapement Goal (SEG), Biological Escapement Goal (BEG), Optimal Escapement Goal (OEG), or other specified management objectives for the fishery." The increased protection provided by commercial, sport, and subsistence fisheries restrictions and closures that have occurred in recent years has been helping the Kvichak River sockeye salmon stock recover: minimum escapement goals were met during the last 5 years (2005-2009); there was a surplus harvest of Kvichak River sockeye salmon in the commercial fishery from 2005-2009; and return per spawner has improved in recent years. Even with these recent improvements, there is still need for concern. Therefore, it is recommended that the Kvichak River sockeye salmon stock remain a stock of concern, but be reclassified from a "Stock of Management Concern" to a "Stock of Yield Concern."
5(4): 399-417	Pacific salmon *(Oncorhynchus* spp.) accumulate substantial nutrients in their bodies as they grow to adulthood at sea. These nutrients are carried to predominantly oligotrophic lakes and streams, where they are released during and after spawning. Research over more than 3 decades has shown that the annual deposition of salmon-borne marine-derived nutrients (MD-nutrients) is important for the productivity of freshwater communities throughout the Pacific coastal region. However, the pathways and mechanisms for MD-nutrient transfer and accumulation in freshwater and riparian ecosystems remain virtually unexplored, consequently, there are many uncertainties in this area. This article addresses three related topics. First, we summarize recent advances in our understanding of the linkages among MD-nutrients, freshwater (including riparian) ecosystems, and community dynamics by addressing the importance of MD-nutrients to lakes and streams and by then reviewing large scale and long-term processes in the atmosphere and ocean that govern variability in salmon populations. Second, we evaluate the validity of the discoveries and their implications for active ecosystem management, noting areas where extrapolation from these results still requires great caution. Finally, we outline five key research issues where additional discoveries could greatly augment our understanding of the processes shaping the structure and dynamics of salmon populations and the characteristics of their freshwater habitat and associated riparian zones. Collectively, the data suggest that the freshwater portion of the salmon production system is intimately linked to the ocean. Moreover, for the system to be sustainable, a holistic approach to management will be required. This holistic approach will need to treat climate cycles, salmon, riparian vegetation, predators, and MD-nutrient flowpaths and feedbacks as an integrated system.

16(2): 4-21	The American Fisheries Society herein provides a list of depleted Pacific salmon, steelhead, and sea-run cutthroat stocks from California, Oregon, Idaho, and Washington, to accompany the list of rare inland fishes reported by Williams et al. (1989). The list includes 214 native naturally spawning stocks: 101 at high risk of extinction, 58 at moderate risk of extinction, 54 of special concern, and one classified as threatened under the Endangered Species Act of 1973 and as endangered by the state of California. The decline in native salmon, steelhead, and sea-run cutthroat populations has resulted from habitat loss and damage, and inadequate passage and flows caused by hydropower, agriculture, logging, and other developments; overfishing, primarily of weaker stocks in mixed-stock fisheries; and negative interactions with other fishes, including nonnative hatchery salmon and steelhead. While some attempts at remedying these threats have been made, they have not been enough to prevent the broad decline of stocks along the West Coast. A new paradigm that advances habitat restoration and ecosystem function rather than hatchery production is needed for many of these stocks to survive and prosper into the next century.
	Mineral extraction, whether it be by surface or underground mining in their diverse forms, affects salmonids and their habitats in many ways. Increasing public awareness of the value of aquatic resources has led to legislation designed to protect, restore, or enhance areas that have been or will be mined. This positive trend has also led to a growing body of knowledge about the specific effects of mining-related pollutants on salmon and trout and the mechanisms by which habitat degradation may be reversed. Some of the adverse effects of mining on salmonid habitats are obvious. Placer mining converts natural streams to channels between barren rubble piles; hydraulic mining erodes hillsides and deposits the eroded material into nearby streams. Road building and removal of surface vegetation may also contribute to direct streambed disturbances and sediment influxes. Other influences, however, may be less obvious and much more insidious. One of the principal and most persistent results of mining is acid mine drainage. Both orphaned and currently operated mines may contribute acidic drainage to nearby waters. Acid production can occur in coal deposits by the generation of sulphuric acid or through the action of oxidizing bacteria on pyrite, a common component of the granitic material in which many western ore deposits occur. The consequences of acid drainage are many and they are expressed in a variety of ways. If pH levels are sufficiently low, fish populations may be reduced directly through fish kills or less directly through reduction in the viability of individuals, their gametes, or their progeny. Aquatic invertebrates, an important source of food for many salmonids, may also be affected by acid drainage; they may be directly poisoned or their habitats may be degraded by deposition of ferric hydroxide. In addition, the toxicity of many metallic poisons is increased at low pH levels. Tailings piles and settling ponds also may contribute pollutants. Cyanide, a highly toxic chemical that is often used to recover gold, has sometimes entered streams through failure of settling ponds. Acid drainage through tailings piles contributes metallic pollutants to nearby waterways. Many metals (including arsenic, cadmium, chromium, copper, iron, and uranium) that are either the object of mining or are associated with extraction of other minerals are highly toxic to fish, and their toxicity may be greatly influenced by pH. In many cases, metallic compounds are relatively insoluble in natural waters that are of nearly neutral pH, but become increasingly soluble as acidity increases, thereby increasing the concentration of toxic metal ions.

6	This Draft Environmental Baseline Progress Report provides a description of the work conducted for the Northern Dynasty Mines Inc. (NDM) 2004 baseline environmental program. This Pebble Project progress report presents the characterization of the existing conditions related to environmental and social conditions of the project area and their incorporation into the project design and operation. This draft report is presented for agency and stakeholder review and comment, to ensure the approach followed and results obtained provides a comprehensive and thorough baseline environmental characterization of the Pebble Project.
806	This section discusses the groundwater sampling results from the 2004 field season. The data are analyzed to determine spatial (lateral and vertical) variations and variations with time. The data are also compared with surface water-quality criteria to provide a benchmark for water quality. Based on the results of this analysis, requirements for further data are noted. Groundwater samples were collected in September and October 2004. The study results will be included in the environmental baseline document and are expected to be used for both the design and the permit applications for construction, operation, and closure of the proposed mine. The objective of the following discussion is to report the progress of groundwater sampling and analysis and the current understanding of groundwater chemistry.
119	This section presents the findings of the 2004 fish resources study for the proposed mine area. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that additional data will be collected in 2005. The results presented here should be considered preliminary and are subject to change after additional data have been collected. Objectives of the study were to 1) characterize the distribution and relative abundance of fish resources within and adjacent to the deposit in sufficient detail to provide information for impact assessment and mitigation planning, and 2) acquire predevelopment baseline data for comparison with post-development monitoring.
94	None

27(1): 55-112	None
52	None
115	A study was made of sockeye salmon lake spawning grounds in Iliamna Lake, Alaska. Physical and biological characteristics of a lake shore and an island spawning area were measured. Bottom composition of the lake shore area was 85 percent material 0.1 to 1.7 millimeters in diameter. Bottom composition of the island area was 96 percent material greater tha 6.7 millimeters in diameter. Intergravel water temperatures in the lake shore area were 1°C to 4°C lower than lake water temperature. Little temperature differences were found in the island area. It was concluded that eggs developing in the lake shore area depend on upwelling ground water for water circulation in redds, while in the island area eggs depend on lake water currents for inter-redd water circulation. Rate of sockeye embryo and alevin development was determined by incubating eggs in the hatchery. Development was described by length measurements and anatomical structures. Fifty percent hatched by 643 degree-days, and yolk sac absorption was completed by 933 degree-days. Results were applied to egg samples from study areas to estimate times of hatching and emergence.
47(1): 769	None

33	Stream temperature is an aspect of water quality that affects every aquatic organism. Yet taking that temperature is not as easy as it may seem. Placing a thermometer in a stream and recording the reading are simple enough. The problem is that the result does not represent the entire stream, whose temperatures vary markedly over both time and location. Instead of a single measurement, what is needed is a set of measures that describes a stream's "temperature regime." Even then, the process is complicated. Many factors affect the temperature regime, including climate, riparian or stream bank vegetation, and channel form and structure. The factors with the strongest influence vary from time to time and place to place. What's more, patterns of variation in stream temperature differ depending on the timescale of observation and the size of the area within which temperature is measured. For instance, variation in stream temperature over a single day is apt to differ from variation over an entire year. Similarly, the patterns of temperature observed within a single pool or riffle in a stream are apt to differ completely from the patterns observed along the entire stream course. Stream temperature regimes are difficult to quantify, but available evidence suggests that stream temperature regimes in the Pacific Northwest are now typically different from those that existed before Euro- Americans settled the region. Evidence further shows that a variety of human activities often are responsible for changes in temperature regimes over time and that the effects of human activities often are cumulative: individual land use activities that alone would not substantially alter stream temperature can do so when combined with other activities or with natural disturbances. Alteration of these regimes in turn may contribute to a decline in the family of fish known as salmonids, which until recently has successfully adapted to historical variations in stream temperature. In many streams where large salmon runs once were typical, the temperature regimes now appear inhospitable. Thus, from a scientific perspective, restoration of temperature regimes compatible with desired populations is an important factor in their recovery.

13(3): 401-422	Fishes inhabiting streams and rivers in the interior of North America experience a continental climate. Water temperatures reach 0°C in winter and are high in summer. There is a marked seasonal cycle in discharge. These circumstances make groundwater a crucial component of river habitats. Groundwater can influence the distribution, reproductive success, biomass and productivity, behaviour and movements of fishes, and is especially important in winter and summer. Winter flows are minimal and are affected by ice. In winter, the importance of groundwater increases northwards. Groundwater provides overwintering habitat free of subsurface ice and fish may migrate long distances to take advantage of it. The melt season can account for up to half the annual discharge. In summer, groundwater is important for maintaining discharge and moderating stream temperatures. During critically hot weather, groundwater refugia protect species exposed to temperatures approaching their thermal limits. Since groundwater exerts such an important influence on river habitats, its quality, quantity and sustainability should be considered before development proposals are approved which could alter it. Examples of the role of groundwater in the ecology of some species show how localised and critical habitats influenced by groundwater can be, and, in consequence, how necessary it is to protect them. Protection is complicated because groundwater distribution pathways are often unknown and recharge areas may be remote from discharges. Scale becomes important in identifying potential risks to critical stream habitats from all types of landscape modification and water abstraction. Groundwater temperatures reflect mean annual air temperatures and are likely to change as global climates respond to increases in the greenhouse gases in the atmosphere. This could profoundly change critical fish habitats, particularly those at the margins of species distributions or those that are already overcrowded. Such considerations emphasise the importance of developing proper strategies for the conservation of groundwater.

378	Few subjects have generated as much emotional dialogue around conflicting scientific and policy agendas as the protection and management of Pacific salmon resources. In this major new work, esteemed fisheries expert Thomas Quinn distils from the vast scientific literature the essential information on the behaviour and ecology of Pacific salmon, including steelhead and cutthroat trout. Unlike other books that examine only selected life stages, habitats, or species, this book - richly illustrated with beautiful photographs and original drawings - thoroughly covers the complete life cycle, emphasizing common themes and differences among the various species of salmon. Representing the range of species and geographic regions, Quinn includes examples from classic studies by pioneers of salmon biology and from the most current research to illustrate the important features of salmon life history and behaviour and the complex physical, biological, and human factors that affect them. "The Behavior and Ecology of Pacific Salmon and Trout" introduces salmon and trout as a group, with a brief description of each species, and compares them to other fishes. This book then follows salmon on their amazing homeward migration from the open ocean, through the complex coastal waters, and upstream to the precise location where they were spawned years earlier. It explains the patterns of mate choice, the competition for nest sites, and the fate of the salmon after their death. It describes the lives of offspring during the months they spend incubating in gravel, growing in fresh water, and migrating out to sea to mature. Quinn emphasizes the importance of salmon to humans and to natural ecosystems and the need to integrate sound biology into conservation efforts. This thorough, up-to-date survey should be on the shelf of anyone with a professional or personal interest in Pacific salmon and trout. Written in a technically accurate but engaging style, it will appeal to a wide range of readers, including students, anglers, biologists, conservationists, legislators, and armchair naturalists.
87: 195-203	Predation on Pacific salmon by bears (genus *Ursus* L., 1758) can be an important ecosystem process because the spatial distribution of carcasses largely determines whether marine-derived nutrients cycle through aquatic or terrestrial pathways. Direct observations on three streams in southeastern Alaska indicated that 49% of the pink (*Oncorhynchus gorbuscha* (Walbaum, 1792)) and chum (*Oncorhynchus keta* (Walbaum in Artedi, 1792)) salmon killed by bears were carried into the forest. The tendency of bears to tranport carcasses was independent of the sex and species of salmon, but unspanwed fish were more often transported than fish that had completed spawning. Data on tagged sockeye salmon (*Oncorhynchus nerka* (Walbaum in Artedi, 1792)) in one southwestern Alaska stream indicated that 42.6% of the killed salmon were transported, and that higher percentages were transported in years when salmon densities were greater. At six other streams, on average, 68.1% of the sockeye salmon killed were apparently transported away from the stream into the forest. Combining the data from all sites, the proportion of carcasses transported increased with water depth at the site. These results emphasize the role that bears play in mediating the interactions between nutrients from salmon and the terrestrial and aquatic ecosystems, and the variation in carcass distribution among streams and among years.

24: 391-411	Salmonids spawn in highly diverse habitats, exhibit strong genetic population structuring, and can quickly colonize newly created habitats with few founders. Spawning traits often differ among populations, but it is largely unknown if these differences are adaptive or due to genetic drift. To test if sockeye salmon (*Oncorhynchus nerka*) populations are adapted to glacial, beach, and tributary spawning habitats, we examined variation in heritable phenotypic traits associated with spawning in 13 populations of wild sockeye salmon in Lake Clark, Alaska. These populations were commonly founded between 100 and 400 hundred sockeye salmon generations ago and exhibit low genetic divergence at 11 microsatellite loci (F_{ST}\0.024) that is uncorrelated with spawning habitat type. We found that mean P_{ST} (phenotypic divergence among populations) exceeded neutral F_{ST} for most phenotypic traits measured, indicating that phenotypic differences among populations could not be explained by genetic drift alone. Phenotypic divergence among populations was associated with spawning habitat differences, but not with neutral genetic divergence. For example, female body color was lighter and egg color was darker in glacial than non-glacial habitats. This may be due to reduced sexual selection for red spawning color in glacial habitats and an apparent trade-off in carotenoid allocation to body and egg color in females. Phenotypic plasticity is an unlikely source of phenotypic differences because Lake Clark sockeye salmon spend nearly all their lives in a common environment. Our data suggest that Lake Clark sockeye salmon populations are adapted to spawning in glacial, beach and tributary habitats and provide the first evidence of a glacial spawning ecotype in salmonids.
2: 306-328	Abundance estimates of wild and hatchery Pacific salmon *Oncorhynchus* spp. are important for evaluation of stock status and density-dependent interactions at sea. We assembled available salmon catch and spawning abundance data for both Asia and North America and reconstructed total abundances of pink salmon *O. gorbuscha*, chum salmon *O. keta*, and sockeye salmon *O. nerka* during 1952-2005. Abundance trends were evaluated with respect to species, regional stock groups, and climatic regimes. Wild adult pink salmon were the most numerous salmon species (average = 268 x10^6 fish/year, or 70% of the total abundance of the three species), followed by sockeye salmon (63 x 10^6 fish/year, or 17%) and chum salmon (48 x 10^6 fish/year, or 13%). After the 1976-1977 ocean regime shift, abundances of wild pink salmon and sockeye salmon increased by more than 65% on average, whereas abundance of wild chum salmon was lower in recent decades. Although wild salmon abundances in most regions of North America increased in the late 1970s, abundances in Asia typically did not increase until the 1990s. Annual releases of juvenile salmon from hatcheries increased rapidly during the 1970s and 1980s and reached approximately 4.5 x 10^9 juveniles/year during the 1990s and early 2000s. During 1990-2005, annual production of hatchery-origin adult salmon averaged 78 x 10^6 chum salmon, 54 x 10^6 pink salmon, and 3.2 x 10^6 sockeye salmon, or approximately 62, 13, and 4%, respectively, of the combined total wild and hatchery salmon abundance. The combined abundance of adult wild and hatchery salmon during 1990-2005 averaged 634 x 10^6 salmon/year (498 x 10^6 wild salmon/year), or approximately twice as many as during 1952-1975. The large and increasing abundances of hatchery salmon have important management implications in terms of density-dependent processes and conservation of wild salmon populations; management agencies should improve estimates of hatchery salmon abundance in harvests and on the spawning grounds.

1(1): 31-37	One of the most spectacular phenomena in nature is the annual return of millions of salmon to spawn in their natal streams and lakes along the Pacific coast of North America. The salmon die after spawning, and the nutrients and energy in their bodies, derived almost entirely from marine sources, are deposited in the freshwater ecosystems. This represents a vital input to the ecosystems used as spawning grounds. Salmon-derived nutrients make up a substantial fraction of the plants and animals in aquatic and terrestrial habitats associated with healthy salmon populations. The decline of salmon numbers throughout much of their southern range in North America has prompted concern that the elimination of this "conveyor belt" of nutrients and energy may fundamentally change the productivity of these coastal freshwater and terrestrial ecosystems, and consequently their ability to support wildlife, including salmon. If progress is to be made towards understanding and conserving the connection between migratory salmon and coastal ecosystems, scientists and decision-makers must explore and understand the vast temporal and spatial scales that characterize this relationship.
86(12): 3225-3231	For decades ecologists have recognized the potential importance of marine derived nutrients (MDN) deposited in freshwater ecosystems by spawning anadromous salmon. Previous studies have shown that some MDN are retained in freshwater ecosystems. A popular hypothesis linking MDN to salmon population productivity posits that MDN provided by post-spawning mortality of salmon are critical for salmon population dynamics because they enhance prey populations in the freshwater ecosystems used as nursery habitats. We tested this hypothesis by reconstructing historical sockeye salmon populations for the last 300 years in Bristol Bay, Alaska. Stable nitrogen isotope chronologies in lake sediments and sockeye catch and escapement histories show that commercial fisheries intercepted about two-thirds of MDN bound for freshwater spawning grounds since about 1900. Reconstruction of lake algal production using fossil pigments shows that this loss of MDN has reduced lake algal productivity to about one-third of its level before commercial fishing. However, contrary to expectation, recent sockeye population sizes (sum of spawning escapement and fishery catch) in the last century were equivalent to those before the advent of commercial fishing. These data demonstrate that the MDN subsidy is important for the productivity of coastal lakes but that some sockeye salmon populations are limited by other features of ecosystems such as the amount of suitable spawning habitat.

465: 609-612	One of the most pervasive themes in ecology is that biological diversity stabilizes ecosystem processes and the services they provide to society, a concept that has become a common argument for biodiversity conservation. Species-rich communities are thought to produce more temporally stable ecosystem services because of the complementary or independent dynamics among species that perform similar ecosystem functions. Such variance dampening within communities is referred to as a portfolio effect and is analogous to the effects of asset diversity on the stability of financial portfolios. In ecology, these arguments have focused on the effects of species diversity on ecosystem stability but have not considered the importance of biologically relevant diversity within individual species. Current rates of population extirpation are probably at least three orders of magnitude higher than species extinction rates, so there is a pressing need to clarify how population and life history diversity affect the performance of individual species in providing important ecosystem services. Here we use five decades of data from *Oncorhynchus nerka* (sockeye salmon) in Bristol Bay, Alaska, to provide the first quantification of portfolio effects that derive from population and life history diversity in an important and heavily exploited species. Variability in annual Bristol Bay salmon returns is 2.2 times lower than it would be if the system consisted of a single homogenous population rather than the several hundred discrete populations it currently consists of. Furthermore, if it were a single homogeneous population, such increased variability would lead to ten times more frequent fisheries closures. Portfolio effects are also evident in watershed food webs, where they stabilize and extend predator access to salmon resources. Our results demonstrate the critical importance of maintaining population diversity for stabilizing ecosystem services and securing the economies and livelihoods that depend on them. The reliability of ecosystem services will erode faster than indicated by species loss alone.

8(4): 297-314	Salmonids are an important component of biodiversity, culture and economy in several regions, particularly the North Pacific Rim. Given this importance, they have been intensively studied for about a century, and the pioneering scientists recognized the critical link between population structure and conservation. Spatial structure is indeed of prime importance for salmon conservation and management. At first glance, the essence of the metapopulation concept, i.e., a population of populations, widely used on other organisms like butterflies, seems to be particularly relevant to salmon, and more generally to anadromous fish. Nevertheless, the concept is rarely used, and barely tested. Here, we present a metapopulation perspective for anadromous fish, assessing in terms of processes rather than of patterns the set of necessary conditions for metapopulation dynamics to exist. Salmon, and particularly sockeye salmon in Alaska, are used as an illustrative case study. A review of life history traits indicates that the three basic conditions are likely to be fulfilled by anadromous salmon: (i) the spawning habitat is discrete and populations are spatially separated by unsuitable habitat; (ii) some asynchrony is present in the dynamics of more or less distant populations and (iii) dispersal links populations because some salmon stray from their natal population. The implications of some peculiarities of salmon life history traits, unusual in classical metapopulations, are also discussed. Deeper understanding of the population structure of anadromous fish will be advanced by future studies on specific topics: (i) criteria must be defined for the delineation of suitable habitats that are based on features of the biotope and not on the presence of fish; (ii) the collection of long-term data and the development of improved methods to determine age structure are essential for correctly estimating levels of asynchrony between populations and (iii) several key aspects of dispersal are still poorly understood and need to be examined in detail: the spatial and temporal scales of dispersal movements, the origin and destination populations instead of simple straying rates, and the relative reproductive success of immigrants and residents.
32	A stock assessment of rainbow trout *Oncorhynchus mykiss* was conducted during spring and fall 2004 on the Tazimina River in response to reports by user groups of decreased abundance and reduced fish size. From 22 April to 28 May 2004 a mark-recapture experiment to estimate abundance resulted in an estimate of 950 (SE = 213) rainbow trout in river of which 16% (SE = 2.3%) were sexually mature. Sampled fish ranged from 161 to 612 mm FL with a mean length of 307 mm (SE = 4.10). Between 19 and 27 August 2004 CPUE and length distribution were estimated for comparison with past research conducted during the same time frame. Four hundred fourteen (414) rainbow trout were captured with a CPUE of 3.23 rainbow trout per hour. Length distribution ranged from 82 to 518 mm with a mean of 285 mm (SE = 4.15). CPUE during 2004 was higher than previous years; however, the proportion of fish over 500 mm FL was lower.

44: 1-19	Collections of stomachs from belukha whales taken by Eskimo subsistence hunters in the Bering and Chukchi Seas have greatly increased the data available on spring and summer foods in those areas. During spring migration in the Chuckchi Sea feeding seems influenced by ice conditions. Spring foods include arctic cod, shrimps and octopus. In coastal areas of the northern Bering and Chukchi Seas, summer foods include saffron cod, sculpins, herring, smelt, capelin, salmon, char, shrimps and octopus. Saffron cod was the primary prey species in Norton Sound and Eschscholtz Bay in June. Other species of fishes are eaten in relation to their seasonal patterns of distribution and abundance. Based on information from coastal residents and the literature, similar foods are used in summer from Bristol Bay to the northeastern Chukchi Sea. In Eschscholtz Bay young belukhas ate smaller saffron cod than older animals and males ate proportionately more sculpins than did females. During autumn and winter months pollock are probably the major prey in the southeastern and southcentral Bering Sea while arctic and saffron cods are probably the most important prey in more northerly areas. Prey eaten by belukhas are similar to those eaten by many species of pinnipeds and other cetaceans and harvested by commercial fisheries. Competition for food with other marine mammals and with fisheries may influence population size and productivity of belukhas.
317	None
13(2): 104-110	We examined the site fidelity of spawning adult sockeye salmon (*Oncorhynchus nerka*) by tagging and releasing fish in the same stream reach (controls) and displacing them among different but nearby sites (c. 50 m away). Three sites - two above a stream junction ('upper' reach and 'pond') and one below ('lower' reach) - allowed us to compare the behavior of salmon in the presence and absence of olfactory cues and habitat similarity. Most controls of both sexes (90%) remained in the immediate vicinity of the tagging and release site. When displaced downstream, where the odors of both the upper reach and the pond were detectable, most salmon returned to their former site (65%). Displaced sockeye were more likely to return to the pond from the lower reach than from the upper one ($P = 0.05$), consistent with olfactory orientation and the hypothesis that salmon prefer certain habitats. Salmon displaced from the upper to the lower reach were much more likely to return than those displaced to the pond ($P < 0.01$), consistent with the role of odors in orientation and inconsistent with the habitat choice hypothesis.

67(1): 77-85	Salmonid fishes aggregate for breeding at spatially defined, suitable habitats. These aggregations may evolve into discrete populations when precise natal homing leads to reproductive isolation, and local regimes of selection lead to adaptation. Population structure is often defined by persistent differences in selectively neutral genetic markers and in mean values of morphological and life-history traits between locations. This approach is limited by the spatial scale at which traits diverge; low levels of reproductively successful straying, combined with similar selective pressures on life-history traits resulting from similar habitat features and environmental conditions, can significantly reduce the power of these discriminatory methods. We compared data on three life-history traits and polymorphism of DNA microsatellites for evidence of population subdivision among sockeye salmon spawning on spatially discrete but physically similar beaches on islands in Iliamna Lake, Alaska. We found small but significant differences in average body length, body depth and age composition between sites as well as significant interactions between site and year. These interactions, reflecting random variation in growth or recruitment among sites, are a powerful tool for discriminating populations with similar mean trait values. These results suggest fine-scale homing to natal sites, but the microsatellite data revealed no evidence of restricted gene flow among sites. There seems to be enough straying among the populations to prevent differentiation at neutral traits but enough homing for them to be functionally distinct.
67	None
38	The stocks of sockeye salmon, *Oncorhynchus nerka*, in Bristol Bay, Alaska, are produced in the lakes and streams of 10 major river systems, which discharge into the bay over a shoreline distance of 193 km. The establishment of fishing areas, the determination when fishing may be permitted, and the effect of exploiting simultaneously several stocks of sockeye salmon require knowledge of the migratory pattern of the individual stocks comprising the run to Bristol Bay during spawning migration. Various mark-and-recapture experiments and exploratory fishing in the eastern Bering Sea and Bristol Bay provide a picture of the migratory pattern of Bristol Bay sockeye salmon from approximately longitude 170 W to the head of Bristol Bay. The main migration route of all stocks of Bristol Bay sockeye salmon is in the offshore waters of the southern half of the entrance to the bay and in the southern half of the bay itself. All stocks remain in the offshore waters until within 32 to 80 km of their home-river systems. Segregation according to river of origin apparently began in the offshore waters as much as 200 km from the mouths of the home-river systems and appeared to progress to the head of Bristol Bay.

14(4): 969-974	Although excessive loading of fine sediments into rivers is well known to degrade salmonid spawning habitat, its effects on rearing juveniles have been unclear. We experimentally manipulated fine bed sediment in a northern California river and examined responses of juvenile salmonids and the food webs supporting them. Increasing concentrations of deposited fine sediment decreased growth and survival of juvenile steelhead trout. These declines were associated with a shift in invertebrates toward burrowing taxa unavailable as prey and with increased steelhead activity and injury at higher levels of fine sediment. The linear relationship between deposited fine sediment and juvenile steelhead growth suggests that there is no threshold below which exacerbation of fine-sediment delivery and storage in gravel bedded rivers will be harmless, but also that any reduction could produce immediate benefits for salmonid restoration.
21(6): 1609-1625	The North Pacific Ocean has been of great significance to understanding biogeography and speciation in temperate faunas, including for two species of char (Salmonidae: *Salvelinus)* whose evolutionary relationship has been controversial. We examined the morphology and genetics (microsatellite and mitochondrial DNA) of Arctic char (*Salvelinus alpinus*) and Dolly Varden char (*Salvelinus malma*) in lake systems in western Alaska, the eastern and western Arctic, and south of the Alaskan Peninsula. Morphologically, each lake system contained two forms: one (Arctic char) largely confined to lake habitats and characterized by greater numbers of pyloric caeca, gill rakers, and shallower bodies, and another (Dolly Varden) predominated in adjacent stream habitats and was characterized by fewer pyloric caeca, gill rakers, and deeper bodies. MtDNA partial (550 bp) d-loop sequences of both taxa were interspersed with each other within a single 'Bering' clade and demographic inferences suggested historical gene flow from Dolly Varden to Arctic char had occurred. By contrast, the taxa were strongly differentiated in sympatry across nine microsatellite loci in both lakes. Our data show that the two taxa are highly genetically distinct in sympatry, supporting their status as valid biological species, despite occasional hybridization. The interaction between these species highlights the importance of the North Pacific, and Beringia in particular, as an evolutionary wellspring of biodiversity.

743	The upper reaches of the Kvichak River system extend into Lake Clark National Park and Preserve. This system is the world's most productive spawning and rearing habitat for sockeye salmon. It contributes about 50 percent of sockeye salmon caught in Bristol Bay, 33 percent of the entire catch in the United States, and 16 percent of the total world catch. Wildlife abounds in and near the park and preserve. The Mulchatna caribou herd, numbering nearly 200,000 and said to be the most stable and healthiest herd in Alaska, grazes and calves along the western boundary of the park and preserve. Dall sheep and moose forage the area, and brown and black bear, wolves, lynx, foxes, and other mammals are present. Fish include five species of salmon, rainbow trout, Dolly Varen, lake trout, northern pike, and Arctic grayling. On the Cook Inlet side of the park and preserve, swans and other waterfowl nest on marshes and outwash plains and rocky cliffs in and adjacent to the park provide rookeries for puffins, cormorants, kittiwakes, and other seabirds. Seals and whales may be seen occassionally offshore. The park and preserve contains significant cultural resources since the area has been occupied since prehistoric times. Dena'ina Indians lived at Kijik on Lake Clark until the early 1900s, when they moved to Nondalton and other sites. Other prehistoric sites are located near Lake Telquana and along the upper Mulchatna River. Russian explorers, fur traders, and missionaries began traversing the region in the 1790s. The salmon industry began attracting white settlers in the early 1900s. While most of the early settlers around Lake Clark were trappers and miners, recent years have seen the development of an economy based on subsistence lifestyles, commercial fishing, and recreation activities.
9	None
1	None
7	None
7	None

7	None
37: 130-137	From headwaters to mouth, the physical variables within a river system present a continuous gradient of physical conditions. This gradient should elicit a series of responses within the constituent populations resulting in a continuum of biotic adjustments and consistent patterns of loading, transport, utilization, and storage of organic matter along the length of a river. Based on the energy equilibrium theory of fluvial geomorphologists, we hypothesize that the structural and functional characteristics of stream communities are adapted to conform to the most probable position or mean state of the physical system. We reason that producer and consumer communities characteristic of a given river reach become established in harmony with the dynamic physical conditions of the channel. In natural stream systems, biological communities can be characterized as forming a temporal continuum of synchronized species replacements. This continuous replacement functions to distribute the utilization of energy inputs over time. Thus, the biological system moves towards a balance between a tendency for efficient use of energy inputs through resource partitioning (food, substrate, etc.) and an opposing tendency for a uniform rate of energy processing throughout the year. We theorize that biological communities developed in natural streams assume processing strategies involving minimum energy loss. Downstream communities are fashioned to capitalize on upstream processing inefficiencies. Both the upstream inefficiency (leakage) and the downstream adjustments seem predictable. We propose that this River Continuum Concept provides a framework for integrating predictable and observable biological features of lotic systems. Implications of the concept in the areas of structure, function, and stability of riverine ecosystems are discussed.

47: 517-539	1. This review is presented as a broad synthesis of riverine landscape diversity, beginning with an account of the variety of landscape elements contained within river corridors. Landscape dynamics within river corridors are then examined in the context of landscape evolution, ecological succession and turnover rates of landscape elements. This is followed by an overview of the role of connectivity and ends with a riverine landscape perspective of biodiversity. 2. River corridors in the natural state are characterised by a diverse array of landscape elements, including surface waters (a gradient of lotic and lentic waterbodies), the fluvial stygoscape (alluvial aquifers), riparian systems (alluvial forests, marshes, meadows) and geomorphic features (bars and islands, ridges and swales, levees and terraces, fans and deltas, fringing floodplains, wood debris deposits and channel networks). 3. Fluvial action (erosion, transport, deposition) is the predominant agent of landscape evolution and also constitutes the natural disturbance regime primarily responsible for sustaining a high level of landscape diversity in river corridors. Although individual landscape features may exhibit high turnover, largely as a function of the interactions between fluvial dynamics and successional phenomena, their relative abundance in the river corridor tends to remain constant over ecological time. 4. Hydrological connectivity, the exchange of matter, energy and biota via the aqueous medium, plays a major though poorly understood role in sustaining riverine landscape diversity. Rigorous investigations of connectivity in diverse river systems should provide considerable insight into landscape-level functional processes. 5. The species pool in riverine landscapes is derived from terrestrial and aquatic communities inhabiting diverse lotic, lentic, riparian and groundwater habitats arrayed across spatio-temporal gradients. Natural disturbance regimes are responsible for both expanding the resource gradient in riverine landscapes as well as for constraining competitive exclusion. 6. Riverine landscapes provide an ideal setting for investigating how complex interactions between disturbance and productivity structure species diversity patterns.
127: 637-344	We used mark–recapture techniques to examine the effects of four types of road crossings on fish movement during spring base flows and summer low flows in small streams of the Ouachita Mountains, west-central Arkansas. We assessed movement for 21 fish species in seven families through culvert, slab, open-box, and ford crossings and through natural reaches. We detected no seasonal or directional bias in fish movement through any crossing type or the natural reaches. Overall fish movement was an order of magnitude lower through culverts than through other crossings or natural reaches, except no movement was detected through the slab crossing. In contrast, open-box and ford crossings showed little difference from natural reaches in overall movement of fishes. Numbers of species that traversed crossings and movement within three of four dominant fish families (Centrarchidae, Cyprinidae, and Fundulidae) also were reduced at culverts relative to ford and open-box crossings and natural reaches. In spring, retention of fishes was consistently highest in stream segments upstream of crossings and lowest in downstream segments for all crossing types, a response attributed to scouring associated with spring spates. Water velocity at crossings was inversely related to fish movement; culvert crossings consistently had the highest velocities and open-box crossings had the lowest. A key requirement for improving road crossing designs for small-stream fish passage will be determination of critical levels of water velocity through crossings.

3(1): 1-6	Total dissolves solids (TDS) are naturally present in water or are the result of mining or some industrial treatment of water. TDS contain minerals and organic molecules that provide benefits such as nutrients or contaminants such as toxic metals and organic pollutants. Current regulations require the periodic monitoring of TDS, which is a measurement of inorganic salts, organic matter and other dissolved materials in water. Measurements of TDS do not differentiate among ions. The amount of TDS in a water sample is measured by filtering the sample through a 2.0 µm pore size filter, evaporating the remaining filtrate and then drying what is left to a constant weight at 180°C. The concentration and composition of TDS in natural waters is determined by the geology of the drainage, atmospheric precipitation and the water balance (evaporation-precipitation). The mean salinity of the world's rivers is approximately 120 mg/L and the major anion found in natural waters is bicarbonate. The most commonly occurring cation in fresh water is calcium. Changes in TDS concentrations in natural waters often result from industrial effluent, changes to the water balance (by limiting inflow, by increased water use or increased precipitation), or by salt-water intrusion. It is recommended that different limits for individual ions, rather than TDS, be used for salmonid species. These limits should be based on the effect of the ion on fertilization and egg development.
88(1): 191-200	Pacific herring (*Clupea pallasi*) eggs were collected from spawning grounds in Bristol Bay, Alaska, transferred to Norway for hatching, and for 63 days raised in a 2000-m^3 marine basin located at the Flodevigen Biological Station. The eggs were from the same spawning, and hatching took place over 3 days. Upon completion of hatching, 24,840 larvae (12.42 larvae/m^3) were released into the basin. Larval growth was rapid and metamorphosis was observed 28 days after hatching at a length of 25 mm. The experiment was terminated by draining the basin; 4891 juveniles were recovered. The average rate of growth was 0.66 mm/day in length and 2.89 mg/day in weight. The larval length frequency, unimodal at hatching, segregated into three modes within 2 weeks, which persisted until termination. The slowest growth rate was 0.31 mm/day and the larger herring averaged 1.48 mm/day. At first feeding, copepod nauplii were abundant but food declined later. Cannibalism was observed on day 45 and a 30-mm herring was captured that contained a 20-mm herring. Survival was higher in the basin than estimated for larvae at sea. Mortality appeared to be greatest during the first 2 weeks, and much of it may have been due to hydromedusa predation.
62	The salmon spawning ground report is compiled annually to report the results of spawning ground surveys conducted by the Division of Commercial Fisheries staff in Bristol Bay. The report describes the conditions under which salmon were observed and other factors affecting escapement data. Although data have been collected for more than 20 years in most cases, appendix tables contain only information from the last 20 years to give the data context.

4: 513-519	In February 2006, the US Supreme Court heard cases that may affect whether intermittent streams are jurisdictional waters under the Clean Water Act. In June 2006, however, the cases were remanded to the circuit court, leaving the status of intermittent streams uncertain once again. The presence of commercial species, such as coho salmon (*Oncorhynchus kisutch*), can be an important consideration when determining jurisdiction. These salmon spawn in the upper portions of Oregon coastal stream networks, where intermittent streams are common. In our study of a coastal Oregon watershed, we found that intermittent streams were an important source of coho salmon smolts. Residual pools in intermittent streams provided a means by which juvenile coho could survive during dry periods; smolts that overwintered in intermittent streams were larger than those from perennial streams. Movement of juvenile coho into intermittent tributaries from the mainstem was another way in which the fish exploited the habitat and illustrates the importance of maintaining accessibility for entire stream networks. Loss of intermittent stream habitat would have a negative effect on coho salmon populations in coastal drainages, including downstream navigable waters.
9(3): 489-497	Many wildlife species feed on anadromous fishes of several life-history stages. There is evidence for some wildlife species that the availability of anadromous fish is critically important for survival or reporduction. In some regions anadromous fishes in fresh water appear to be keystone food resources for vertebrate predators and scavengers, forging an ecologically significant link between aquatic and terrestrial ecosystems. The spatial distribution of anadromous fish in fresh water, including the occurrence of runs in very small streams, has important consequences for wildlife biology (social interactions, distribution, activity patterns, possibly survivorship) and conservation of biodiversity.
48(6): 455-462	(From Introduction): Anadromous and inshore-spawning marine fish provide a rich, seasonal food resource that directly affects the biology of both aquatic and terrestrial consumers and indirectly affects the entire food web that knits the water and land together. In addition, the authors suggest that the presence of a seasonally abundant food resource has helped to shape the evolution of aquatic and terrestrial consumers and that predators have proabably exerted reciprocal evolutionary pressures on their prey, potentially influencing the life history and morphology of these fishines. Finally, the authors suggest that anadromous and inshore-spawning fishes constitute such an important prey base for terrestrial wildlife that conventional ecology dogmas need to be revised. Interactions between anadromous fishes and wildlife have been recognized as having some general ecological importance (e.g., Brown 1982), but only recently have the ramifcations of these interactions and their potential magnitude begun to be explored. Because many of the ecological links still need to be described and quantified, the authors concentrate on sketching an outline of the interactions, documenting the effects where possible but also noting effects that seem probable, subject to future research.

120: 98-105	A spatially intensive survey in 1989 of 52 sites in the Red River drainage in southwest Oklahoma and surveys in all years from 1978 to 1987 on four sites in the drainage provided evidence that construction of Altus Dam on the North Fork of the Red River caused major changes in fish community structure in the river above the dam. Pre-impoundment data on the fish communities were scanty, but the inferences they allowed were similar to those obtained by comparing fish assemblages in the North Fork above the dam with assemblages elsewhere in the drainage, particularly along Salt Fork, which had similar habitat characteristics. Twenty-five species were collected in the North Fork above Altus Dam, compared to 33 in the Salt Fork and 34 in the North Fork below the dam. The speckled chub *Macrhybopsis* (formerly *Hybopsis*) *aestivalis* and the chub shiner *Notropis potteri* were absent in the North Fork above Altus Dam but fairly common in similar streams elsewhere in the area. The plains minnow *Hybognathus placitus* and the Red River shiner *Notropis bairdi* were among the most common fish species found in southwest Oklahoma, but were not collected above Altus Dam in the 1989 survey and were collected only intermittently and in small numbers in the long-term survey. We speculate that these two species have repeatedly been extirpated and have been reestablished as bait-bucket introductions since the dam was closed. Upstream of the reservoir, the sand shiner *Notropis stramineus* and the emerald shiner *Notropis atherinoides* replaced the plains minnow and the Red River shiner as dominant species, and several reservoir species were more common. Significant negative association at two long-term sites suggested that the sand shiner and Red River shiner were filling similar niches.
126(4): 699-706	The South Fork basin of the Coeur d'Alene River, Idaho, has been an area of heavy mining activity since the 1880s. The mining operations have resulted in elevated concentrations of metals in surface water, most notably cadmium, lead, zinc, and, to a lesser extent, copper. The metals affected surface water quality downstream in the Coeur d'Alene basin and are suspected to be one of the primary reasons for the reduction in populations of native westslope cutthroat trout Oncorhynchus clarki lewisi. The avoidance response of a surrogate species, Snake River cutthroat trout O. clarki (unnamed subspecies), was evaluated against conditions simulating those in the Coeur d'Alene River basin. Cutthroat trout avoided a metals mixture of these concentrations: Cd (0.30 µg/L), Cu (6.0 µg/L), Pb (0.6 µg/L), and Zn (28 µg/L). The avoidance response to either Cu or Zn alone was similar to the avoidance response to the mixture, suggesting that avoidance to the mixture was due to these metals. After acclimation to Zn at 55 µg/L for 90 d, cutthroat trout detected and preferred a lower Zn concentration of 28 µg/L. The lowest Zn concentrations avoided (28 µg/L) were 1/6 to 1/78 the Zn concentrations measured in the South Fork and lower Coeur d'Alene River basins. Avoidance of metals-contaminated habitats by cutthroat trout may be, in part, responsible for reduced fish populations.

64	Recent declines in the number of sockeye salmon returning to Lake Clark caused economic hardship in the region and raised resource concerns among local subsistence users and Federal managers. This final report describes findings from a two year study with two primary objectives: 1) to identify sockeye salmon spawning areas using radio telemetry, and 2) to describe genetic variation within and divergence among spawning populations. Radio Telemetry Research: A lack of information regarding spawning habitat distribution in Lake Clark instigated this study. To determine spawning distributions, 332 adult sockeye salmon were radio tagged as they entered Lake Clark in 2000 and 2001. Fish were relocated every 5-10 days by boat, plane, or remote solar powered receiver. On average, a radio tagged fish was relocated 12.7 times (range, 3 - 33) and over 3,500 relocations were made. Thirty-five spawning areas were identified, including three sites downstream of the tagging area and five sites identified by visual observation or seining. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Spawning habitat locations were mapped into the Geographic Information System for Lake Clark National Park and Preserve. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; most of which were adjacent to an obvious clear water source. About 75% of identified spawning habitats are adjacent to privately owned lands, many slated for development. Proactive measures should be taken to conserve these habitats. Genetics Research: Prior to this study genetic information was lacking for Lake Clark originating sockeye salmon populations. Molecular genetic markers provide managers with more precise tools with which to identify and manage fish populations. Small clips of fin tissue (non-lethal) were obtained from 1,442 sockeye salmon representing 13 Lake Clark and 2 northeastern Lake Iliamna spawning populations in 2000 and 2001. Allele frequencies differed significantly across 11 microsatellite loci in 94 of 105 pair-wise population comparisons. Pairwise estimates of F_{ST} ranged from 0 to 0.089. There is significant genetic divergence between populations of Lake Clark and Sixmile Lake, the latter being more similar to fish of Lake Iliamna. The reduced numbers of alleles and strong divergence of most Lake Clark populations relative to Lake Iliamna/Sixmile Lake populations suggest a bottleneck or period of low population abundance, resulting in reduced genetic diversity. The greatest bottleneck effect detected and the most genetically distinct population was found in Sucker Bay Lake. Possible causes of these bottlenecks include reductions in effective population size associated with recent poor returns or colonization of new spawning habitats. Samples shared with the Alaska Department of Fish and Game for a Bristol Bay wide analysis indicate Lake Clark originating sockeye salmon are easily
19	Although humpback whitefish are the second most important subsistence fish species harvested in the Kvichak River watershed, few data are available to assist managers in evaluating a reported recent decline in this species' abundance. Initial research on humpback whitefish in Lake Clark National Park began in 2005, and indicates they are both attracted to and derive nutrients from anadromous sockeye salmon. Our growth equations (Figure 8) indicate rapid growth until age 4 - 7, which is likely when individuals become sexually mature which would slow growth rates. The lack of individuals of intermediate sizes could be due to differences in year class strength, selection by the subsistence fishery, or predators. After fish reach a size of ≥380 mm, predation likely declines and mortality in the population may stabilize at a low level for the rest of the life span. The lack of a strong Sr spike in the 10 otoliths analyzed for anadromy suggests Lake Clark whitefish either remain in freshwater throughout their life, or that they use estuarine areas with very low salinities. The high variation observed in the Sr signal of

48	Combined stream survey data for 2008 - 2010 indicated salmon presence in 3 of every 4 headwater streams of less than 10% gradient draining to an anadromous river, including streams on top of the Pebble Prospect. Rearing salmon were documented above dry stream reaches and in waters disconnected from rivers suggesting salmon access such sites during annual floods or via subsurface groundwater channels. Non-salmon species important to subsistence, such as Dolly Varden char, were found in 96% of streams surveyed. A total of 168 km (104.3 miles) of previously undocumented salmon streams, were nominated for the first time to the State's Anadromous Water Catalog. The State accepted all 2008 and 2009 new salmon stream nominations, available at (http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm) and 2010 nominations are currently under review. Aerial survey data verified adult salmon presence in an additional 358 km (253 miles) of streams and rivers that needed confirming data. This study underscores both the importance of headwater streams as essential rearing habitat for salmon and the lack of basic ecological information for two of the world's most productive salmon systems, the Nushagak and Kvichak River watersheds.
35	This report describes findings from a sockeye salmon *Oncorhynchus nerka* radio telemetry and spawning habitat study conducted in the Lake Clark watershed in 2000 and 2001. The primary objectives of this research were 1) to locate and map all major spawning aggregations 2) to determine basic characteristics of spawning habitats, and 3) to determine the distribution of private land uses and subsistence/sport use locations in relation to salmon spawning habitats. Thirty-five spawning areas were identified. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; however, the timing of spawning activity in turbid habitats coincided with a dramatic decrease in the concentration of suspended sediment and turbidity. Water quality parameters were all within acceptable range for freshwater aquatic life. Subsistence fishing for migrating sockeye salmon occurs throughout Lake Clark near seasonal and year-round residences. Residents of Nondalton harvest red fish (spawning sockeye salmon) from spawning areas. Sport harvest occurs at the outlet of Lake Clark, the outlet of Tanalian River, and within the Kijik Lake drainage. Subsistence and sport fishers currently harvest less than one percent of the Lake Clark escapement. About 75% of identified spawning habitats are adjacent to privately owned lands, many slated for development. Proactive measures should be taken to conserve these habitats.
N/a	None
N/a	None

	None
35	None

Annotation	Muncipal water supplies	404(c) Categ
The purpose of the study was to obtain current estimates of the economic contribution of sportfishing activities to the Alaska economy and develop a consistent method for producing such estimates on a regular basis. Sportfishing is important to Alaska's economy and culture. The vast majority of sportfishing takes place in the Southcentral region of Alaska, which includes Bristol Bay. $989 million were spent in 2007 in the Southcentral region, 11,535 jobs were supported by the industry, and $91 million were generated in state and local taxes. Expenditures are analyzed. About half of sportfishers are Alaska residents, and the remaining half travel from out of state.		
A map depicting water bodies in the USGS Naknek quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.		
A map depicting water bodies in the USGS Dillingham quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.		
A map depicting water bodies in the USGS Iliamna quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.		
A map depicting water bodies in the USGS Lake Clark quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.		
A table with sport fish harvest in southcentral Alaska (including Bristol Bay) listed by species for salmon, resident fish, as well as smelt, halibut, shark, rockfish, lingcod, Pacific cod, razor clams, and other fish. May be obtained from the ADFG website: http://www.sf.adfg.state.ak.us/Statewide/FishingSurvey/index.cfm?FA=region.results.		
ADFG news release describing the 2010 Bristol Bay Salmon season. The run was estimated at 40.19 million fish, with a preliminary catch estimate of 29 million sockeye ranking 17th and 11th, respectively, since statehood. The inshore run was 6% above the annual 20-year average (1990-2009) of 37.97 million, and 1% higher than forecasted. The Naknek-Kvichak District harvested 10.66 million fish, 28% higher than forecast, while the Nushagak District harvested 8.3 million sockeye making it the second largest harvest in the history of that district. Other salmon harvest numbers are included for Bristol Bay: 31,400 Chinook, 1.09 million chum, 104,000 coho, and 1.34 million pink salmon for an overall harvest of approximately 31 million fish. The ex-vessel value of the 2010 fishery is calculated as $153,115,042. Additional details regarding allocation and species performance are included in the release. This news release is preliminary to report which will be published in the coming calendar year.		

This document includes 40 maps outlining land designations and habitat areas in Bristol Bay for marine invertebrate gathering, waterfowl trapping, salmon, freshwater fish, marine mammals, caribou, geese, shorebirds, gulls and terns, eagles, Stellar's eiders, brown bears, and swans for each community.	
This document describes lure restrictions for rainbow trout and lists catch-and-release and fly-fishing only areas in Southwest Alaska. It includes a map detailing fishing restrictions.	
None	Yes

None	
None	

None	
None	

None	
Addresses the impacts of roads to salmonid rivers in headwater streams.	
The article highlights the importance of habitat diversity of Bristol Bay sockeye salmon to local adaptation.	

None	
A dichotomous taxonomic key to fishes of the Kvichak including 22 known species captured by seining, gill netting, trawling, angling, tow netting, and rotenoning.	
This report is one of very few that provide baseline habitat data in the Bristol Bay drainage area. Kijik Lake is outside of the area that would be directly impacted by mineral development, though the spawning salmon populations migrate through the project area to reach spawning beds in Kijik lake.	Yes

The report documents sockeye and coho salmon as well as rainbow trout, Dolly Varden, Arctic grayling, threespine and ninespine stickleback, northern pike and slimy sculpin in Upper Talarik Creek, the South Fork Koktuli River, and the North Fork Koktuli River in the vicinity of the copper deposit. Chinook salmon and burbot are also documented in the South Fork Koktuli River, and Chinook, chum, least cisco and humpback whitefish are documented in the North Fork Koktuli River. Only resident fish species are documented in the Chulitna River drainage, including Dolly Varden, Arctic grayling, pygmy whitefish, longnose sucker, ninespine stickleback, and slimy sculpin. Slimy sculpin were the most abundant and widely distributed fish species in the region, followed by Dolly Varden. Spawning sockeye and their carcasses are documented in Upper Talarik Creek downstream of the North Fork confluence in general agreement with the State of Alaska's Anadromous Waters Catalog (AWC). Coho were found throughout the Upper Talarik and North Fork Koktuli River, in extension of their distribution shown in the AWC at that time, and the author states that 'it is strongly suspected that the very extensive network of connected backwater areas and side	
None	

None	
None	
None	

The Alagnak River in the Kvichak drainage is generally accessed by floatplanes from King Salmon or area lodges. This report documents the number of anglers in both boats and rafts on four reaches of the river from June through August. Angling was most common in the lower river, with as many as 110 anglers per day.	
None	
The basic features of stream ecosystem structure and various functional ecological components and their interrelationships are defined for some representative streams. The article focuses on two general functions of running waters: the efficient conversion of organic matter, especially particulates, to CO_2 and the maintenance of a minor role played by in-stream plant growth. The article ends with a plea to incorporate the 'new stream ecology' into management strategies directed at freshwater resources, suggesting that management at the time the article was written was too anthropocentric.	
None	

None	
Describes the water source for Clark's Point as spring-fed wells. Water is treated with chlorine and flouride. Commercial fishing forms the economic base for the community. Fish and salmon subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes the water source for Dillingham as three deep wells. Water is treated and piped to 40% of the community. The remaining 60% use individual wells. Commercial fishing, fish processing and storage, and other support for the fishing industry forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources of individuals as wells, or surface water from a nearby unnamed lake. Ekuk was formerly home to a fish packing company. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes the water source for Ekwok as primarily individual wells. Fish and wildlife subsistence activities are crucial to the livelihood of residents as most residents are not interested in participating in a cash economy. A handful of residents fish commercially, and the village corporation owns a fishing lodge. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes the water source for Igiugig as the Kvichak River due to inadequate groundwater supplies. Should mining commence, the risk of drinking water contamination of the Kvichak River exists. Residents depend on the commercial salmon fishery as well as fish and wildlife subsistence activities. Trophy rainbow trout attract sport fishermen to the area, and seven commercial lodges operate in Igiugig, serving sport fishermen and hunters. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Iliamna as individual wells. Commercial fishing, sport fishing and tourism are listed as major sources of income for the community. Subsistence hunting and fishing is also an important source of livelihood for the community. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for King Salmon as primarily shallow individual wells, and a small community well for FAA housing. Commercial fishing is important to the King Salmon Economy, as is tourism given its proximity to Katmai National Park and Preserve. Sportfishing is also popular in the area. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Kokhanok as a piped water system as well as a separate well and treatment facility for the local school. Commercial fishing is an important, if declining economic base in the community. Most residents rely heavily on fish and wildlife subsistence. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water source for Levelock as individual wells. Commercial fishing, fish processing, and storage form the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes Naknek's water source as primarily individual wells. Commercial fishing and processing are central to the economy of the village. Government is another source of employment in the village. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA	Yes
Describes water source for New Stuyahok as treated community well water. The salmon fishery forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Newhalen as treated water derived from a community well. Commercial fishing and sport fishing for trophy rainbow trout provide economic opportunities in Newhalen. Residents also depend on fish and wildlife to support their subsistence lifestyle. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Nondalton as treated surface water from Six-Mile Lake. Commercial fishing and subsistence hunting are primary sources of livelihood in the village. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Pedro Bay as individual wells or surface water from Iliamna Lake. Employment consists largely of commercial fishing and tourism services. Subsistence hunting and fishing is also an important source of livelihood. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Port Alsworth as individual wells or hauled water from nearby surface water sources. The economic base of Port Alsworth relies on lodges and outfitters/guides for summer recreation, as well as limited commercial fishing. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Portage Creek as hauled from downriver (Portage Creek). Residents depend on fish and wildlife subsistence activities, and a lodge operates during the summer. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes South Naknek's water source as primarily individual wells (surface or groundwater are not indicated), and some piped water. Commercial fishing and processing are central to the economy of the village, and residents depend on subsistence hunting and fishing. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
None	
The study was conducted in the Pedro Pond complex, a group of ponds connected to the east end of Iliamna Lake near the village of Pedro Bay.	

None	
Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
None	

None	
The paper describes the Kvichak River system as the largest producer of sockeye salmon in Alaska, as well as the history of the Bristol Bay fishing industry and the sockeye runs. Population dynamics of the fishery are modeled, and management alternatives are discussed based on the results.	

The Alaska Fishery Research Bulletin may be obtained at the following website: http://www.adfg.state.ak.us/pubs/afrb/afrbhome.php.	
The report includes a map of areas used by Manokotak hunters to harvest moose and marine mammals, and documents edible weight of subsistence for Manokotak and Dillingham at 2006 and 715 pounds, respectively. Mean household harvest is documented for 19 Bristol Bay communities for salmon, other fish, marine invertebrates (butter and razor clams), land mammals, marine mammals, furbearers, birds and eggs, and plants. Response to growing hunting pressure by recreational hunters is discussed.	

Similar reports for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
This report briefly describes the subsistence fisheries of the Bristol Bay Management Area, with a primary focus on the salmon fisheries. It is based on information gathered through the department's subsistence salmon permit system and from research conducted by the Division of Subsistence. The population, communities and cash economy of the region are described. General harvests in Bristol Bay are described as amongst the largest in the state and include salmon (51% of the harvest), land mammals (mostly moose and caribou, 31%), non-salmon fish (10%), and other resources such as marine mammals, birds and eggs, marine invertebrates, and wild plants (8%). The average annual value of the average household subsistence in the region is estimated at $7,195 overall, and $11,420 in village households in a region with average annual income of $13,154. Subsistence regulations are described and subsistence permit use is characterized. Results indicate subsistence salmon harvest has declined more than half in the last two decades, primarily in the Nushagak and Naknek/Kvichak districts as the result of lower average catches rather than less participation by residents. Declines are attributed to poor returns and scarcities of salmon in once reliable traditional harvest locations. The report concludes that subsistence fishing is crucial to the economy and way of life of Bristol Bay, providing nutritional and economic value, and supporting cultural and social values.	

Bristol Bay subsistence is described in pages 63-74. Regulations are discussed, and subsistence harvests are estimated at 124,679 fish for 2007, the majority of which were sockeye salmon (80%). Subsistence harvest is broken down by region. Subsistence for non-salmon fish are also described, including halibut, Alaska blackfish, burbot, Arctic grayling, Arctic char, Dolly Varden, lake trout, longnose suckers, rainbow smelt, rainbow/steelhead trout, herring, northern pike, and whitefish. Similar reports for previous years can be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
Analysis for Port Alsworth, Nondalton, Iliamna, and Newhalen. Kvichak River sockeye salmon comprise the largest subsistence harvest in Bristol Bay, but are listed as a "stock of management concern" due to the stock's chronic inability to meet escapement goals. The study indicates that poor returns were a factor responsible for steadily declining harvest since the 1960s. Declining returns are of great concern to residents. Subsistence harvest between the four communities has ranged from about 30,000 to nearly 90,000 sockeye salmon since 1963, comprising from 44% to 89% of the total subsistence harvest. The report includes maps of subsistence fish camps and harvest locations on Iliamna Lake, Sixmile Lake, Lake Clark, and the Newhalen River. Fishing and processing is described and illustrated. Kinship relations between subsistence fishers as well as distribution of fish about the village are described using case studies. Winter fishing and non-salmon fishing are also discussed briefly. Declining populations of caribou and moose are discussed as an explanation for higher harvest goals for salmon in recent years. Increased fuel costs are a major concern in the region and also may increase subsistence harvest goals as the cost of shipping store-bought foods increases accordingly. Cultural and social values of subsistence are explored. The authors conclude subsistence fishers have developed fishing and processing practices that promote conservation and self-management, support family and community connections, as well as spirituality and cultural tradition. The subsistence fishery for these communities ultimately produces many thousands of pounds of nutritious, virtually irreplaceable food.	
None	

The report describes the high-seas distribution, migrations and identification of major stocks of sockeye salmon together with the relationship of distribution to the environment. A brief discussion of the life history of sockeye salmon and of the spawning stocks is provided as background information. The report concludes with a section detailing the distribution and hypothetical models of migration of stocks of sockeye salmon of Asia and North America. Page 4 includes a map representing locations of important sockeye salmon river systems and average annual commercial catch of sockeye salmon in important coast and high seas fishing areas, 1961-1971. Bristol Bay is the only region on the map with a commercial catch of over 5 million fish, documenting it as the world's largest commercial sockeye salmon fishery.	
In light of the crisis of salmon declines in the Pacific Northwest and the billions of dollars spent unsuccessfully to restore them, the authors review the growing body of literature examining the importance of salmon derived nutrient subsidies to both freshwater and riparian communities. The Bristol Bay region is used to illustrate the magnitude of nutrients imported from the ocean, as much as 5.4×10^7 kg of Nitrogen, 2.7×10^5 kg of Ca, plus other macroelements for a run of 20 million sockeye. Those nutrients disperse as far upstream in freshwater as suitable habitat is accessible, extending the interface between ocean and land. A multitude of species interact with and benefit from those nutrients including bears, insects, birds, benthos, zooplankton, and riparian vegetation. Salmon-derived nutrients increase lake productivity, macroinvertebrate growth, and juvenile salmon growth thereby increasing their survival. Birds associated with riparian habitat are found in greater densities on salmon streams. The carrying capacity of bears increases vastly where salmon are available. Fitness-related variables, including growth rates, litter sizes, and reproductive success, have been attributed to salmon availability for salmon consumers such as eagles, bears, and mustelids, highlighting the importance of salmon to their population dynamics. Management implications of reviewed research is discussed and the authors point out that artificially placing carcasses is not a realistic management decision due to the magnitude of carcasses that would be needed, and stream fertilization does not support the terrestrial environment like salmon. The authors indicate that the preservation of processes related to salmon-derived nutrients is of particular importance.	
The report documents tagging undertaken in 1922 to determine spawning grounds of the important sockeye salmon fishery in what was known at the time as the Alaska Peninsula Fisheries Reservation. Sockeye tagged and released at Unga Island, of the Sumagin Island Group, and Port Moller are documented for the first time returning to Naknek, Kvichak, and Nushagak fishing grounds in Bristol Bay, indicating some of their marine range.	

None	
The article includes figures and data regarding salmon-derived nitrogen in nursery lakes in Bristol Bay dating back to A.D. 1700 as well as annual catch of western Alaska sockeye salmon.	
None	

A preeminent text on Pacific salmon ecology.	
None	

Southwest Alaska and the Arctic-Yukon-Kuskokwim Delta are considered together for the purposes of this report, which provides a profile of sport anglers, the economic significance of sport fishing, and the net economic value to the state. It lists Bristol Bay's Naknek River as Alaska's 9th most popular sport fishing site.	
None	

None	
Lake Iliamna seals are referred to as one of only two populations of harbor seals in the world that reside solely in freshwater without exploiting the marine environment. It indicates that they exhibit no regular movement up or down the river.	

None	
The author hypothesizes that the good biological track record for Bristol Bay arises from four factors: (1) a clear objective of maximum sustainable yield; (2) the escapement-goal system, which assures maintenance of the biological productive capacity; (3) management by a single agency with clear objectives and direct line responsibility; and (4) good luck in the form of lack of habitat loss and good ocean conditions since the late 1970s. Catch and spawner-recruit data are presented for the area, as are landed values for some of the fisheries. The author hypothesizes that the economic failure of the Bristol Bay fishery is due to the converse of the factors leading to biological success: (1) unclear economic objectives, (2) lack of direct agency responsibility for economic performance, and (3) bad luck, and presents potential solutions to economic failure.	
None	

Although the study area would not be directly impacted by mine development, a great deal of tundra ponds, similar in nature exist close to the proposed development.	
This article has implications for fisheries in that the species analyzed serve as important forage items for fish. Climate change may reduce forage densities and size.	

None	
This paper explores the reason the earth supports so many kinds of organisms. It focuses attention on problems of species diversity and community organization that have occupied many theoretical and empirical ecologists before and since it was written. It concludes that taxa containing many diversified species will 'evolve' more readily than undiversified taxa, with limits imposed by brain size and 'niche' space; the evolution of biological communities produces complex inter-relationships which increase the stability of the community as a whole; and that smaller organisms exhibit greater diversity than large ones, and thus the evolutionary processes are different for smaller organisms than for large ones. Hutchinson further notes in dealing with human activities, the stability provided by diversity can be valuable even to the most adaptable of all large animals.	
The article arguably serves as the basis of freshwater biogeochemistry. It is one of the first to discuss streams not as isolated systems, but strongly linked to the valleys that they drain in complex chemical and biological relationships. It describes the influence of valley geology as well as vegetation on inorganic chemistry of streams. It discusses the importance of water source, valley slope, soil permeability, and terrestrial vegetation transpiration to streamflow, referred to as a prime ecological factor in streams. It further describes organic inputs driving water chemistry and stream foodwebs and freshwater macroinvertebrates. Finally, the article underlines large effects resulting from anthropogenic activities in stream valleys.	
Between 1975 and 2008, the Commercial Fisheries Entry Commision (CFEC) issued 1,875 drift gillnet and 1,041 set gillnet permits. Permits held by local Alaskans has dropped while permits to nonlocal Alaskans and nonresidents has increased due to permit transfer, permit holder relocation, and permit cancellation. Earnings are presented and range from a total of $10,529,539 in 1975 to $186,085,765 in 1990 for the drift gillnet fishery and $1,039,384 in 1975 to $26,789,265 in 1988 for the gillnet fishery. Earnings are also presented.	

Addresses the impacts of roads to salmonid systems including extirpation of salmon resulting from low genetic diversity caused by roads crossing salmonid streams.	
Sport fishing participation is broken out by regions in tables at the end of the report. Bristol Bay is included in southcentral Alaska for the purposes of this report.	

This catalog is a numerically-ordered list of the water bodies in the Southwest Region of Alaska with documented use by anadromous fish. An associated Atlas to the Catalog of Water Important for Spawning shows cartographically the location, name and number of each water body, the anadromous fish species documented using them, and the fish life history phases for which the water bodies were documented being used by salmon. Water bodies documented receive statutory protection under sections of AS 16.05.871, which requires persons or governmental agencies to submit plans and specifications to ADFG and receive written approval in the form of a Fish Habitat Permit prior to the proposed use, construction or activities that would take place in specified water bodies. The report is updated annually based on nominations received by ADFG. Previous copies of the catalog can be obtained from ADFG: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/main.overview.	
None	
This article is frequently cited with regard to fish avoidance of culverts installed as part of road construction.	

None	
None	
The report describes wide fluctuations of Bristol Bay sockeye salmon ex-vessel prices since 1975 and salmon harvests. It indicates that that the Bristol Bay salmon fishery accounted for 13% of the world salmon supply in 1980 (including wild and farmed salmon) and 2% of the world salmon supply by 2001. The fishery's value exceeded $200 million in twelve of seventeen years analyzed. Processing and marketing of Bristol Bay salmon is also described. It may be viewed at the following website: www.iser.uaa.alaska.edu/iser/people/knapp.	
The text covers needs and values for sustainable fisheries, current Pacific salmon stock status, existing management of Pacific salmon, habitat assessment, artificial (hatchery and net pen) production, modeling approaches to management, habitat protection and restoration, and recommendations for sustainable management.	

The report indicates that all households in Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, Pedro Bay, and Port Alsworth used freshwater fish, as did 94.4% of households in Nondalton. Rainbow trout made up the largest portion of the total nonsalmon freshwater fish harvest (30.9%), followed by Dolly Varden (26.9%), northern pike (9.9%), lake trout (8.1%), Arctic grayling (7.1%), whitefish (8.3%), suckers (4.9%), rainbow smelt (3.6%), burbot (0.4%), and black fish (<0.01%). Gear used and timing of harvest is evaluated, and harvests are compared to other years. Traditional ecological knowledge interviews describe popular fishing sites for each species exploited. The study documents the continued importance of subsistence harvests of nonsalmon freshwater fish in the communities of the Kvichak River watershed of the Bristol Bay area. Additional studies for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
This study reviews the history and accuracy of water quality predictions for major hardrock mines in the United States by comparing actual water quality to the predictions made in Environmental Impact Statements (EISs) and subsequently identifying common causes of water quality impact and prediction failures. In addition, an analysis was conducted to determine if there were inherent risk factors at mines that may predispose an operation to having water quality problems. Of mines analyzed, 76% had mining-related water quality exceedances in surface or groundwater. Eighty-nine percent of mines with acid drainage predicted low acid drainage potential prior to development. Conclusions are provided about the effectiveness of the underlying scientific and engineering principles used to make water quality predictions in EISs. Finally, recommendations are made for regulatory, scientific and engineering approaches that would improve the reliability of water quality predictions at hardrock mine sites. The document may be downloaded at the following website: http://www.mineralpolicy.org/publications_welcome.cfm. For the mines in their study that developed acid drainage, almost all either underestimated or ignored the potential for acid drainage in their EISs. In terms of predicted (post-mitigation) surface water quality impacts, 73% of the mines in their study having surface water quality impacts predicted low water quality impacts in their initial EISs, two predicted moderate impacts, and two had no information on post- mitigation impacts to surface water resources.	Yes
None	

The chapter discusses landscape, climate, fishing conditions, access, services, costs, as well as fishing highlights for the southwest region. It describes fishing location, access, facilities, highlights, and main species for the following southwest Alaska waterbodies: Lake Iliamna, Kvichak River, Newhalen River, Talarik Creek, Copper River (in the eastern Lake Iliamna drainage), Gibralter River, Lake Clark, Tazimina River, Naknek Lake and River, Brooks River, Alagnak River system, American Creek, Coville-Grosvenor Lakes, Lower Nushagak River, Upper Nushagak, Mulchatna River, Chilikradotna River, Koktuli River, Stuyahok River, Nuyakuk River, Wood-Tikchik Lakes, Tikchik River, Kulukak River, Togiak River system, Becharof Lake system, Ugahsik Lakes system, Ugashik Bay streams, Chignik River, Meshik River, Alaska Peninsula steelhead streams, and Dutch Harbor/Unalaska. Maps are included.	
From the summary: The article indicates that a biotic community cannot clearly be differentiated from its abiotic environment, referring to the sum total as an 'ecosystem.' Organisms within an ecosystem are grouped into a series of discrete trophic levels, categorized as producers, primary consumers, secondary consumers, etc., each of which is successively dependent upon the preceding level as a source of energy. Producers, however, are directly dependent on solar radiation for energy. The more remote an organism is from solar radiation, the less probability it will be dependent solely upon the preceding trophic level. Quantitative relationships between trophic levels are discussed. The percentage loss of energy due to respiration is progressively greater for higher levels in the food cycle. Consumers at higher trophic levels are progressively more efficient in the use of their food supply. Productivity and efficiency increase during earlier phases of successional development (in lakes, productivity and efficiency increase from oligotrophy to eutrophy). And progressive efficiencies of consumer levels appear to increase throughout the aquatic phases of succession.	
None	

None	
This memorandum documents juvenile sockeye rearing in Frying Pan Lake on the South Fork Koktuli as well as juvenile coho above the lake. Juvenile chum salmon are also documented in the drainage.	
Describes habitat requirements for coho salmon including information regarding flow, velocity, substrate, dissolved oxygen, temperature, and other requirements.	
The report concludes for the first time that Bristol Bay and Alaska have an extremely valuable resource in freshwater fish stocks. It indicates that there are suitable commercial stocks of at least Arctic char (6,553 pounds harvested) and whitefish (17,328) in Iliamna Lake Freshwater fish harvest in 1964 yielded $5,645.	
The report describes recreational fishing harvest from 1977 through 1997 for southwest Alaska including the Kvichak and Nushagak Rivers, the former of which is described as the world's largest producer of sockeye salmon and the latter is described as the greatest producer of Chinook, chum, coho and pink salmon in Bristol Bay. Smelt dominate the recreational harvest, likely as a result of their abundance, while sockeye, Chinook, and coho salmon are the most frequently harvested species. Dolly Varden/char, rainbow trout, and arctic grayling are taken to a lesser extent. And lake trout, chum, salmon, Northern pike, whitefish, and burbot are harvested at relatively low levels. The value of the region's recreational fishery was estimated at $50 million for 1988. The report also discusses ongoing and complete research and management studies for the region. Management, angler effort, recreational harvest, and outlooks are documented for drainages in southwest Alaska for Chinook, coho, sockeye, rainbow trout, and other species. Similar area management reports for southwest Alaska for previous years can be found at the ADFG Sport Fish website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	

Similar reports for previous years' analyses can be found on the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
None	

This article does not relate directly to Bristol Bay, but highlights the decline of salmon populations throughout the Pacific Northwest of the United States.	
None	

None	
Results are provided for specific conductance, pH, water temperature, dissolved oxygen, alkalinity and hardness, nutrients, major ions and dissolved solids, total and dissolved trace elements, and low level mercury. Samples were collected from surface and groundwater in the immediate vicinity of the deposit, as well as the area proposed at the time for the road corridor and port facility. Groundwater is characterized around the deposit by low dissolved solids, near neutral pH, average temperature of 4°C, and high dissolved oxygen with few exceptions. Surface water quality around the deposit generally met water quality standards for aquatic-life criteria with the exception of aluminum and alkalinity. The only noted exceedance to water quality standards in groundwater along the road corridor was the pH value from the Newhalen municipal well which was over the criteria of pH 8.5 during both sampling events. Turbidity values also exceeded state water quality samples, though results were not considered reliable. Aluminum standards were exceeded in most sites sampled, and the authors state site specific aluminum criteria would be more appropriate for the area. Alkalinity standards were exceeded in nearly half of the streams sampled along the road corridor, and metals were elevated at two sites.	Yes
The study documents winter fish presence at 39 sample sites in the three tributaries that would be directly impacted by development, all of which contained sections of flowing water during winter months. Salmonids were documented in all three drainages. Spawning surveys were conducted in spring for Arctic grayling and rainbow trout, and in summer and fall for salmon. Fish populations were estimated for Frying Pan Lake using mark-recapture techniques, fish tissue and index monitoring (water quality and quantity, fish, periphyton, macroinvertebrates, and sediment) were conducted at 16 stream and two lake sites. Flow-habitat study sites were established, aquatic habitat was surveyed and mapped, fish abundance sampling was conducted as was qualitative abundance sampling. Along the road corridor, 120 streams were surveyed for fish, and tissue was collected, though results are not presented. Macroinvertebrate sampling in the entire study area yielded 139 taxa, higher than what has been encountered in other mine development baseline monitoring efforts in Alaska; periphyton samples were collected and processed, yielding 38 genera, and basic water quality (dissolved oxygen, temperature, pH, conductivity, and alkalinity) were monitored.	
Describes places important to area residents and users, as well as critical habitat to key plant and animal resources identified through local ecological knowledge. The information was combined with state and federal agency data to create maps. Probable threats to the watershed are identified as commercial development, community development, recreational subdivisions, mining, roads, and global climate change. The plan outlines the following four strategic actions to address those threats: adequate flow reservations in the Nushagak River; vegetation maintenance to support fish, wildlife, and other species in the floodplain; maintenance of water quality standards for salmon and other fish; and to prevent habitat damage that could result from mining.	

This study researched the basic workings of stream ecosystems and factors controlling individual, population, and community productivity in a reach of the Silver Spring River in Florida which is heavily influenced by groundwater. Odum characterized the 'biomass pyramid,' measuring ecosystem metabolism by calculating primary productivity, community productivity, and community respiration. He documented a strong positive correlation between visible light and gross primary production, and concluded that Florida's springs have complex and highly adapted ecologies that have maximized the productive use of available energy inputs, particularly sunlight, nutrients, and current velocity.	
Pages A-64 - A-109 describe impact of non-harvest human activites to salmon fisheries including mining, road building, dam building, water withdrawal, sedimentation, etc. The report states that mining in waters, riparian areas, or flood plains of streams containing or influencing salmon spawning and rearing habitats should be avoided.	
None	
The article argues that the natural flow regime of water plays a critical role in sustaining native biodiversity and ecosystem integrity in rivers. It discusses the effects of river exploitation, river management, and development policies. The authors underline the importance of natural streamflow variability in ecosystems and ecological responses to altered flow regimes.	

The article discusses the importance of tributary and groundwater temperatures and interconnection in maintaining water temperatures critical to salmonid growth.	

None	

This book is a preeminent text on Pacific salmon ecology. It reviews literature from throughout the Pacific Rim, with several articles focusing on research conducted in Alaska's Bristol Bay.	
None	

The article provides evidence for local adaptation of Lake Clark sockeye salmon to glacially turbid spawning streams, such that intensity of visual signals are reduced while weapon size (e.g., snout length and body size) is increased. It concludes that the presence of a glacial ecotype of sockeye salmon suggests that the excellent colonizing ability of the species may be due in part to an ability to adapt quickly to highly unstable, geologically young habitats.	
Figure 6 indicates that Bristol Bay (Central AK in the figure) supports the world's strongest sockeye salmon run.	

None	
None	

None	

Bristol Bay is described as largely pristine with only minimal habitat degradation, unaffected by agriculture, logging or dam building, no hatcheries and sustainable fisheries. The paper concludes: Metapopulation dynamics are, by definition, processes occurring on relatively large scales, often much larger that the territory covered by the jurisdiction of a specific management agency. This is particularly true for anadromous fish species because the series of biotopes they need for their different life stages are spread over large areas of land and ocean.	
The study concludes that the rainbow trout population may be rebounding from depressed levels, and indicates the population is relatively protected due to catch-and-release regulations for sport fishers and the limitation of subsistence fishers to rod-and-reel fishing only. It suggests avenues for further study.	

None	
This report presents the results of a detailed assessment contracted by the Alaska Department of Fish and Game to measure the economic contribution that sportfishing made to the state of Alaska and its regional economies in 2007. The most angler spending in the state occurred in the Southcentral region including Bristol Bay, at 72%. In 2007, 475,534 resident and nonresident licensed anglers fished 2.5 million days in Alaska and spent nearly $1.4 billion on licenses and stamps, trip-related expenditures, pre-purchased packages, and equipment and real estate used for fishing. The $1.4 billion of angler spending in Alaska resulted in economic activity that supported 15,879 jobs in Alaska, provided $545 million of income, and resulted in $123 million in state/local tax revenues. Nonresident angler spending in Alaska in 2007 (economic impact) was $653 million, and this supported 9,437 jobs and $67 million in state/local tax revenues. Total expenditures on guided sportfishing activities in 2007 totaled $416 million, which resulted in $641 million in total economic activity and supported 7,183 jobs. Resident anglers spent an average of $150 per day of sportfishing activity on trip-related expenses in 2007, while nonresident anglers spent an average of $448 per day in Alaska on trip-related expenses in 2007.	
The article indicates that sockeye salmon have the ability to detect relatively small changes in olfactory cues at a very fine scale, and a strong tendency to return to familiar sites, probably using such cues Experimentally displaced salmon returned to their natal site despite much higher likelihood of predation by bears.	

The article underscores the importance of genetically distinct sub-populations to the maintenance of the overall strength of Bristol Bay sockeye salmon.	
This report summarizes information regarding the subsistence use of sockeye salmon and other freshwater fish gathered for a project funded by the US Fish and Wildlife Service, Fisheries Information Services. This project to document traditional ecological knowledge (TEK) was undertaken by the Nondalton Tribal Council in partnership with Lake Clark National Park and Preserve. The information is based on interviews of eighteen Nondalton residents regarding their current and past use of sockeye salmon and other freshwater fish for subsistence. It includes data regarding fishing practices, geographic locations and Dena'ina place names of traditional fishing areas; changes in relative abundance of sockeye salmon and other freshwater fish used for subsistence, and observations of change in the environment. The report does not analyze or interpret responses, but presents information in the words of residents interviewed. Results are presented for sockeye salmon, rainbow trout, Dolly Varden, whitefish, Arctic grayling, northern pike, eulochon (candlefish), suckers, and lake trout.	
None	

None	
None	

The publication outlines the history of Lake Clark National Park and Preserve, as well as surrounding areas, from the prehistoric period through the 1980s.	
The Alaska stock of Pacific walrus is profiled in this document. Its range (including Bristol Bay) is described and illustrated in Figure 1. The world population was last estimated in 2006 at 129,000 animals, the lowest population size estimated for the species. Conflicts between walrus management and commercial fisheries are described, as well as subsistence harvests in the US and Russia. The USFWS received a petition in 2008 to list the Pacific walrus under the US Endangered Species Act. That petition remains under consideration. Particular concerns to Pacific walrus are described as: oil and gas exploration, climate change, and subsistence harvest.	
Non-digital National Wetland Inventory map for the area surrounding the Pebble Deposit. The map was created utilizing 1978-1986, 1:60,000-scale, color-infrared imagery collected as part of the Alaska High Altitude Photography Acquisition Program (AHAP). The data remains to be digitized, and due date for availability of digital data is unknown. Wetlands professionals indicate the map displays extraordinarily extensive wetlands in the area. Codes to interpret the map may be obtained from: http://www.fws.gov/wetlands/_documents/gNSDI/WetlandsDeepwaterHabitatsClassification.pdf.	
The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for Upper Talarik Creek near Iliamna. Similar reports for previous years may be obtained through the USGS website: http://waterdata.usgs.gov/nwis.	
The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for the North Fork Koktuli River near Iliamna. Similar reports for previous years may be obtained through the USGS website: http://waterdata.usgs.gov/nwis.	

The water-data report contains discharge, summary, water quality (width, stage, air, and water temperature) data for the water year (October 2008-2009) for the Koktuli River near Iliamna. Similar reports for previous years may be obtained through the USGS website: http://waterdata.usgs.gov/nwis.	
The article is the first to define the River Continuum Concept.	

None	
None	

None	
One of the first examinations of early life history of Bristol Bay herring which are the largest herring off western North America and genetically distinct from herring in the Gulf of Alaska and off British Columbia. Average growth rate was near the upper end of the range reported from British Columbia and Washington, but greater than that observed in similar experiments in California. High growth rates in Bristol Bay are attributed to summer surface water temperature in the nearshore zone where herring congregate.	
Similar reports for other years may be found at the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	

None	
None	
Discusses the evolving perspective on the interconnectedness between salmon and other anadromous fish species to other fish, whales, sea lions, and numerous terrestrial predators and scavengers, suggesting that the view that predators reduce fish availability for humans is both one-sided and overly limited.	

Highlights potential risks to fisheries from road and dam construction	
None	

None	
None	

None	
None	
None	Yes
None	Yes

The document describes fecal coliform, other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals), and petroleum sheen sampling and results in the lower Nushagak River. The objective was assess whether or not guide camps and/or villages affect bacterial counts, document present-day water quality conditions, and assess motor boat quantity/usage and petroleum sheen presence on the lower Nushagak. Fecal coliform levels exceeded drinking water quality samples at three sites. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with rare exceptions for dissolved oxygen at one site (super-saturation), pH (below 6.0), and dissolved iron at four sites (in exceedance of national secondary drinking water standards). No motorboat effects were observed. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes
The document describes fecal coliform and other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals) sampling and results in the lower Nushagak River. The objective was to build on sampling started the previous year, and to assess sampling locations for suitability for future bioassessment studies. Fecal coliform levels consistently met drinking water quality standards in 2007. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with one exception for dissolved iron at one site (in exceedance of national secondary drinking water standards). Two sites were evaluated for bioassessment suitability and diatom sampling was determined to be the best option for future sampling. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
	Yes		Yes			
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Filename	Keywords (if provided by author/s)
ADFG_2007c.pdf	
ADFG_2008a.pdf	
ADFG_2009a.pdf	
ADFG_2009b.pdf	
ADFG_2009c.pdf	
ADFG_2009d.pdf	
ADFG_2010a.pdf	

ADFG_2010b (folder containing 41 pdfs including 40 habitat maps)	
ADFG_2010c.pdf	
ANDR_1990.pdf	

Baldigo_Lawrence_2000.pdf	
Baldwin_et_al_2003.pdf	

Barry_et_al_2000.pdf	
Bash_et_al_2001.pdf	

Beltman_et_al_1999.pdf	Invertebrates, Metals, Accumulation, Community effects
Bisson_Bilby_1983.pdf	
Blair_et_al_1993.pdf	

Bolliet_et_al_2005.pdf	
Bond_Becker_1963.pdf	
Brabets_Ourso_2006.pdf	

Buell_1991.pdf	
Burgner_et_al_1969.pdf	

Cardinale_et_al_2006.pdf	
Cederholm_et_al_1999.pdf	
Coggins_1992.pdf	Arctic grayling, Thymallus arcticus, Bristol Bay, age, length, weight

Collins_Dye_2005.pdf	Bristol Bay, Alaska Peninsula, Kodiak, Bristol Bay area, Naknek/Kvichak district, Alagnak River, salmon, trout, adult, harvest monitoring, angler effort index
Crouse_et_al_1981.pdf	
Cummins_1974.pdf	
Dallinger_et_al_1987.pdf	Fish, Food, Heavy metal, Food chain effect

Dann_et_al_2009.pdf	Pacific salmon, *Oncorhynchus* spp., sockeye salmon, *Oncorhynchus nerka*, harvest, catch, allocation, commercial fishery, stock, composition, genetics, populaitons, Bristol Bay, Kvichak River, Alagnak Rvier, Naknek River, Egegik River, Ugashik River, Wood River, Igushik River, Nushagak River, Togiak River
DCRA_2010a.pdf	
DCRA_2010b.pdf	
DCRA_2010c.pdf	

DCRA_2010d.pdf	
DCRA_2010e.pdf	
DCRA_2010f.pdf	
DCRA_2010g.pdf	
DCRA_2010h.pdf	
DCRA_2010i.pdf	

DCRA_2010j.pdf	
DCRA_2010k.pdf	
DCRA_2010l.pdf	
DCRA_2010m.pdf	
DCRA_2010n.pdf	
DCRA_2010o.pdf	
DCRA_2010p.pdf	

DCRA_2010q.pdf	
Demory_et_al_1964.pdf	
Denton_et_al_2009.pdf	

Duffield_et_al_2007.pdf	
Dye_Schwanke_2009.pdf	Bristol Bay Sport Fish Management Area, Alaska Board of Fisheries, management plan, Alagnak River, Nushagak River, Mulchatna River, Chinook Salmon, *Oncorhynchus tshawytscha*, king salmon, Kvichak River, sockeye salmon, *Oncorhynchus nerka*, rainbow trout, *Oncorhynchus mykiss*
Eaton_Scheller_1996.pdf	

Ecology_and_Environment_Inc_2010.pdf	
Eggers_Rogers_1987.pdf	

Fair_2003.pdf	
Fall_1990.pdf	

Fall_et_al_2006a.pdf	
Fall_et_al_2006b	

Fall_et_al_2009.pdf	Pacific salmon, sheefish, *Stenodus leucichthys*, whitefish, *Prosopium* spp., *Coregonus* spp., rainbow/steelhead trout, *Oncorhynchus mykiss*, Arctic char/Dolly Varden, *Salvelinus alpinus*, *Salvelinus malma*, northern pike, *Esox lucius*, Chinook salmon, *Oncorhynchus tshawytscha*, sockeye salmon, *Oncorhynchus nerka*, pink salmon, *Oncorhynchus gorbuscha*, chum salmon, *Onchorhynchus keta*, Norton Sound, Port Clarence, Kotzebue, Yukon, Kuskokwim, Bristol Bay, Chignik, Alaska Peninsula, Aleutian Islands, Kodiak, Cook Inlet, Prince William Sound, Southeast Alaska, Yakutat
Fall_et_al_2010.pdf	Kvichak District, Kvichak River, Nondalton, Iliamna, Newhalen, Port Alsworth, Sixmile Lake, Iliamna Lake, Newhalen River, Bristol Bay, Southwest Alaska, Pacific salmon, sockeye salmon, *Oncorhynchus nerka*, subsistence fishing, subsistence salmon processing methods, subsistence harvests, case study method, fish camps, traditional ecological knowledge
Farag_et_al_2003.pdf	

French_et_al_1976.pdf	
Gende_et_al_2002.pdf	
Gilbert_1923.pdf	

Goldstein_et_al_1999.pdf	
Gregory-Eaves_et_al_2009.pdf	
Gresh_et_al_2000.pdf	

This book is not included with the bibliography	
Habicht_et_al_2007.pdf	

Haley_et_al_1999 (a folder containing the Executive Summary, all chapters, and appendices of the report)	
Hansen_et_al_1999.pdf	

Hauser_2007.pdf	
Hauser_et_al_2008.pdf	freshwater harbor seal, *Phoca vitulina*, sockeye salmon, *Oncorhynchus nerka*, Iliamna Lake, scat analysis, seasonal prey, selective predation, consumption patterns

Hilborn_et_al_2003.pdf	
Hilborn_2006.pdf	
Hilderbrand_et_al_1999.pdf	bear, nitrogen, nutrient flow, salmon, spruce

Hildreth_2008.pdf	
Hogg_Williams_1996.pdf	

Huston_1979.pdf	
Hutchinson_1959.pdf	
Hynes_1974.pdf	
Iverson_2009.pdf	

Jackson_2003.pdf	
Jennings_et_al_2006.pdf	Alaska, sport, fish, fisheries, catch, harvest, angler, angler-days, survey, salmon, trout, char, Arctic grayling, northern pike, whitefish, burbot, smelt, Pacific halibut, rockfish, lingcod, razor clams, Alaska Statewide Harvest Survey, Statewide Harvest survey, SWHS

Johnson_Blanche_2010.pdf	
Kaeser_Sharpe_2001.pdf	
Kemp_et_al_2006.pdf	fish, bypass, dams, avoidance, preference, flow

Kendall_et_al_2010.pdf	Alaska, *Anodonta,* climate change, freshwater mussels, growth variation
Kline_et_al_1993.pdf	
Knapp_2004.pdf	
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Krieg_et_al_2005.pdf	Alaska blackfish, Arctic char, Arctic grayling, Bristol Bay, burbot, Dolly Varden, harvest calendars, harvest survey, Igiugig, Iliamna, Kokhanok, Kvichak River watershed, lake trout, Levelock, longnose sucker, Newhalen, Nondalton, northern pike, Pedro Bay, Port Alsworth, rainbow smelt, rainbow trout, traditional ecological knowledge, whitefish
Kuipers_et_al_2006.pdf	
Lauren_McDonald_1986.pdf	

This book chapter is not currently included with the bilbliography	
Lindeman_1942.pdf	
Malmqvist_Hoffsten_ 1999.pdf	benthic macroinvertebrates, copper, heavy metals, species richness, streams

Marcus_et_al_2001.pdf	fluvial, flood plains, mining, sediments, Yellowstone Park, contaminants, pollution
McLarnon_2004.pdf	
McMahon_1983.pdf	
Metsker_1967.pdf	
Minard_et_al_1998.pdf	

Morstad_Baker_2009.pdf	Kvichak River, sockeye salmon, *Oncorhynchus nerka*, stock of concern, commercial fishing, ADF&G, sustainable salmon fisheries policy, Alaska Board of Fisheries, Bristol Bay, Alaska
Naiman_et_al_2002.pdf	anadromous fishes, Pacific salmon, *Onchorhynchus,* marine nutrients, stable isotopes, lake, stream, riparian ecosystems, aquatic productivity, resource management

Nehlsen_et_al_1991.pdf	
This book chapter is not currently included with the bilbliography	

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NDM_2005d.pdf	
NDM_2005h.pdf	
NMWC_2007.pdf	

Odum_1957.pdf	
PFMC_1999.pdf	
Olsen_1964.pdf	
Poff_et_al_1997.pdf	hydrodynamics, rivers -- environmental aspects, streamflow

Poole_et_al_2001.pdf	

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Quinn_et_al_2009.pdf	

Ramstad_et_al_2010.pdf	
Ruggerone_et_al_2010.pdf	

Schindler_et_al_2003 .pdf	
Schindler_et_al_2005 .pdf	biogeochemistry, marine-derived nutrients, mixing model, ^{15}N, paleolimnology, primary production, salmon, salmon enhancement, sediments

Schindler_et_al_2010.pdf	

Schtickzelle_Quinn_2007.pdf	conservation and management, metapopulation dynamics, population structure, salmon, spatial structure, trout
Schwanke_Evans_2005.pdf	Tazimina River, rainbow trout, *Oncorhynchus mykiss*, subsistence, mark-recapture, estimation of abundance, sexual maturity composition, length composition, catch per unit effort, Arctic grayling, *Thymallus arcticus*

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Stewart_et_al_2004.pdf	

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USFWS_2010a.pdf	
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USGS_2009b.pdf	

USGS_2009c.pdf	
Vannote_et_al_1980.pdf	river continuum, stream ecosystems, ecosystem structure, function, resource partitioning, ecosystem stability, community succession, river zonation, stream geomorphology

Ward_et_al_2002.pdf	biodiversity, connectivity, floodplains, landscape ecology, natural disturbance
Warren_Pardew_1998.pdf	

Weber-Scannell_Duffy_2007.pdf	Total Dissolved Solid, TDS, water standards, aquatic organisms, Alaska, salmon
Wespestad_Moksness_1990.pdf	
Westing_et_al_2007.pdf	Bristol Bay Management, commercial fisheries, escapement, spawning, sockeye salmon, Chinook salmon, chum salmon, coho salmon, pink salmon, Naknek, Kvichak, Egegik, Ugashik, Wood, Nushagak, Igushik, Togiak

Wigington_et_al_2006.pdf	
Willson_Halupka_1995.pdf	
Willson_et_al_1998.pdf	

Winston_et_al_1991.pdf	
Woodward_et_al_1997.pdf	

Woody_et_al_2003.pdf	Bristol Bay, genetic bottlenecks, Kvichak River, Lake Clark National Park and Preserve, microsatellites, *Oncorhynchus nerka*, radiotelemetry, sockeye salmon, salmon spawning habitat, salmon genetics, subsistence
Woody_Young_2006.pdf	

Woody_O'Neal_2010.pdf	
Young_2005.pdf	
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Additional notes			

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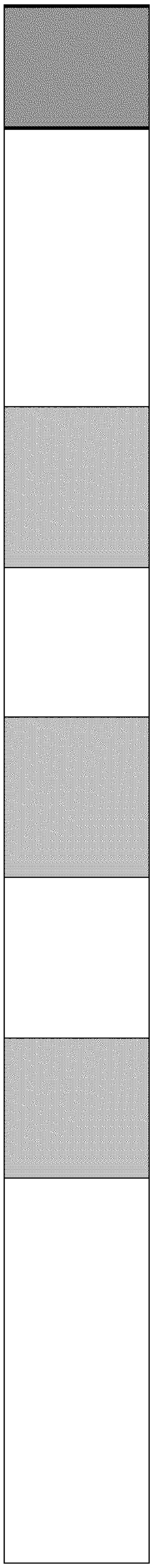

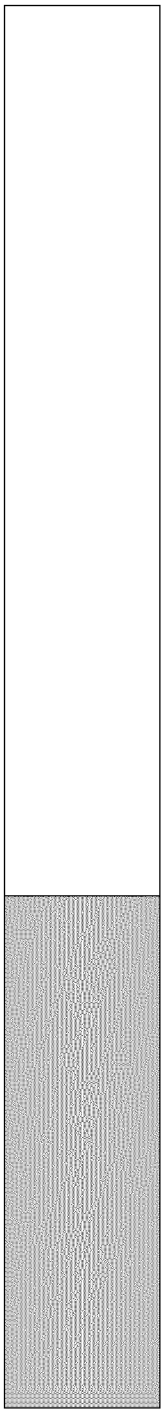

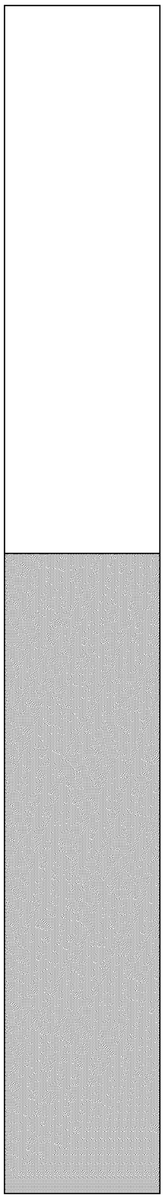

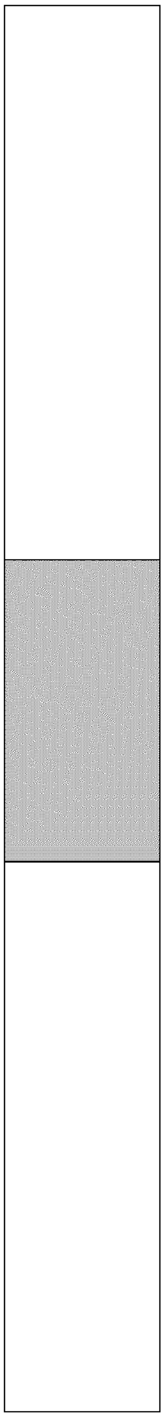

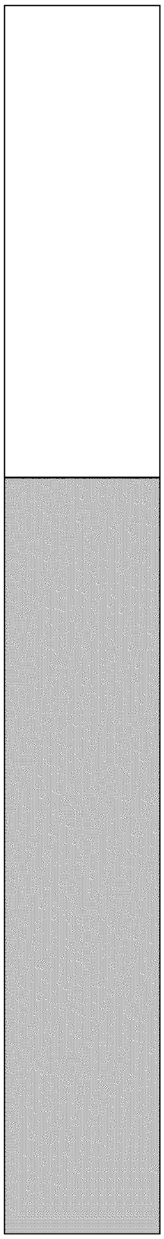

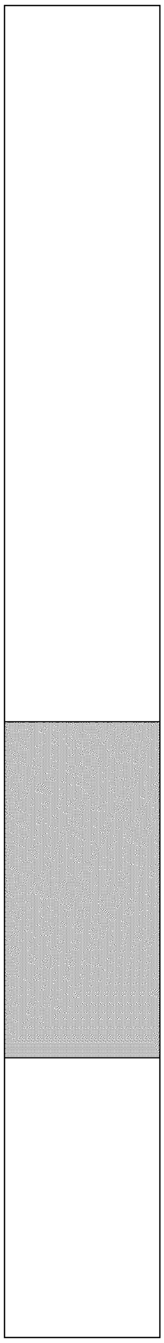

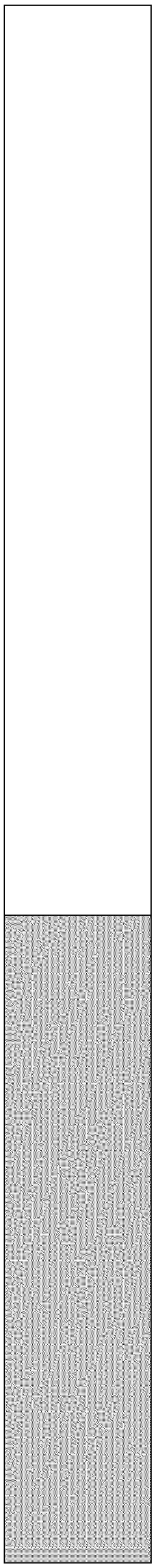

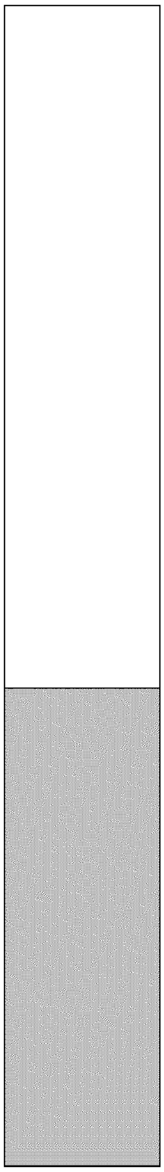

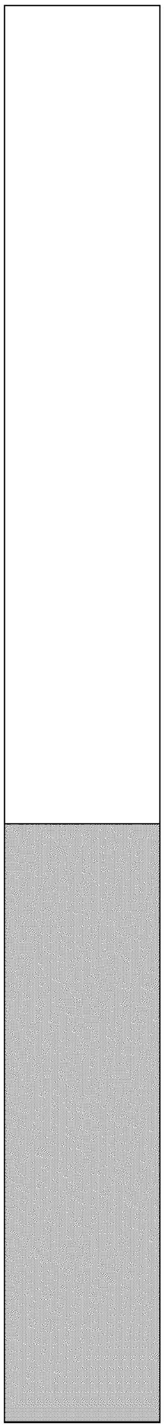

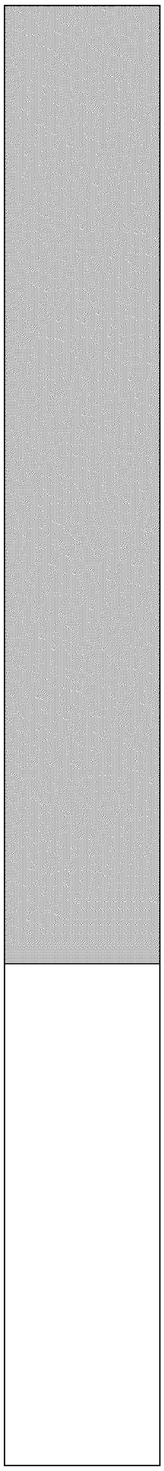

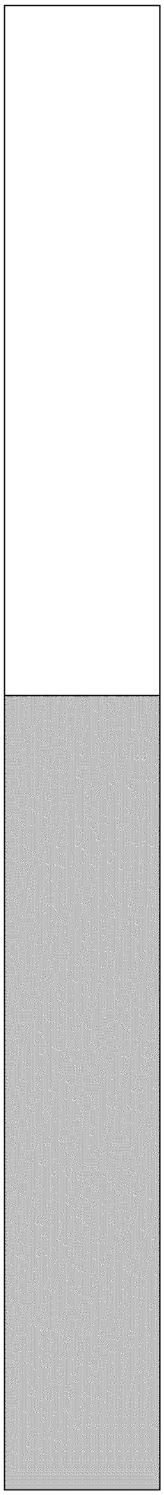

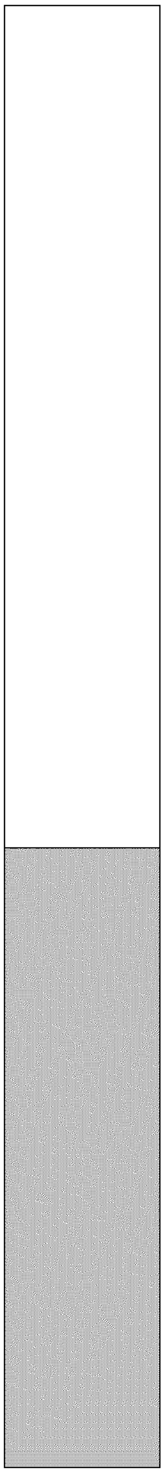

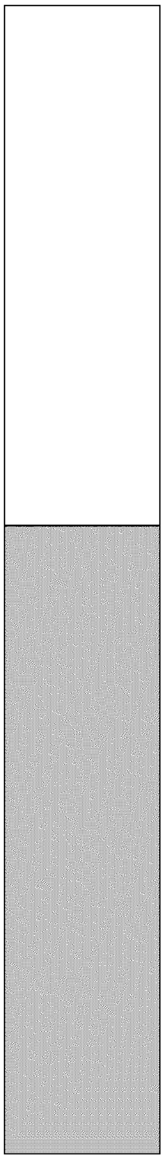

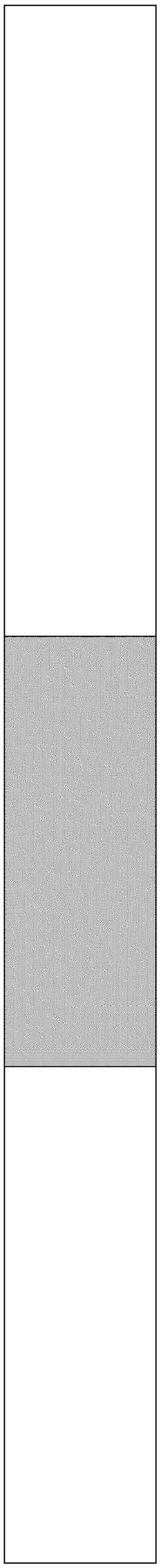

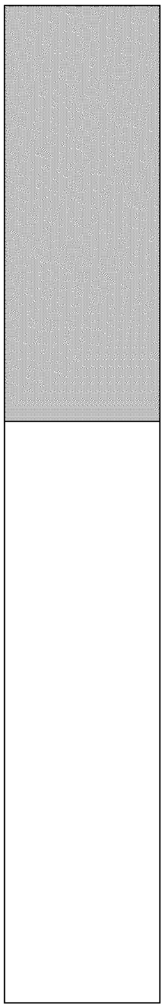

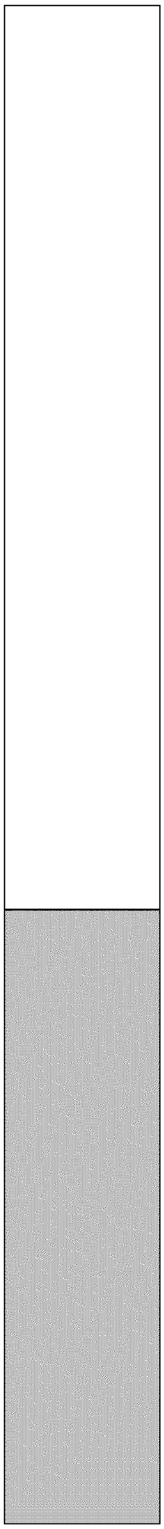

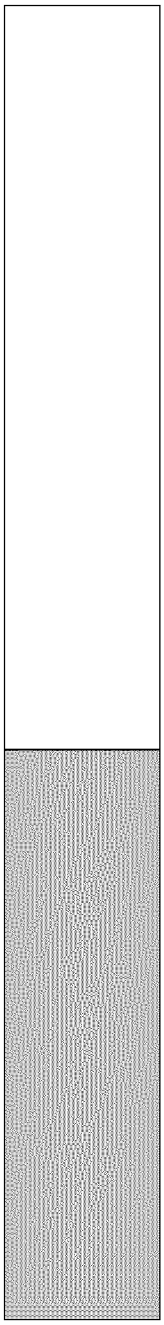

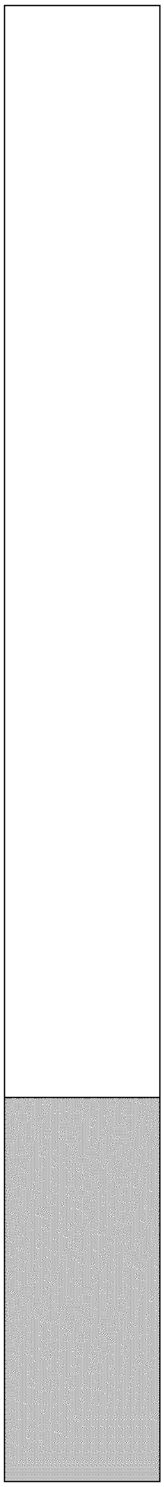

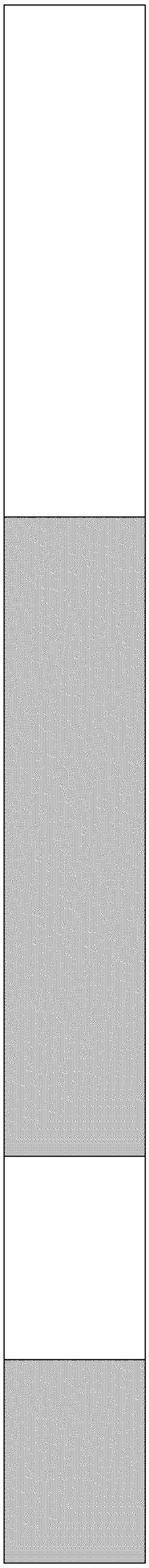

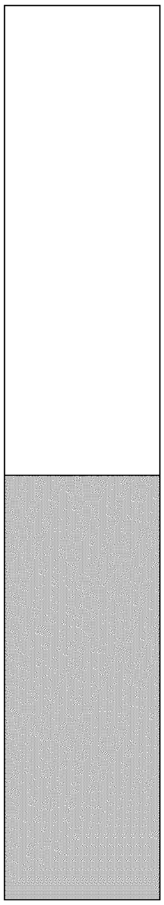

Author	Year	Title	Document Type	Journal/Book Title/Publisher
ADFG (Alaska Department of Fish and Game)	2006	Wolf management report of survey-inventory activities 1 July 2002 - 30 June 2005	Report	ADFG, Division of Wildlife Conservation
ADFG	2007	Brown bear management report of survey-inventory activities 1 July 2004 - 30 June 2006	Report	ADFG, Division of Wildlife Conservation
ADFG	2007	Caribou management report of survey-inventory activities 1 July 2004-30 June 2006	Report	ADFG, Division of Wildlife Conservation

ADFG	2007	Furbearer management report of survey-inventory activities	Report	ADFG, Division of Wildlife Conservation
ADFG	2008	Black bear management report of survey-inventory activities 1 July 2004 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation
ADFG	2008	Moose management report of survey-inventory activities 1 July 2005 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation
ADFG	2010	Bristol Bay critical habitat areas (Egegik, Pilot Point, Cinder River, Port Heiden, and Port Moller) management plan	Government Document	ADFG, Division of Habitat and Division of Wildlife Conservation

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Bornhold, B.D., C.V. Jay, R. McConnaughey, G. Rathwell, K. Rhynas, and W. Collins	2005	Walrus foraging marks on the seafloor in Bristol Bay, Alaska: a reconnaissance survey	Journal Article	Geo-Marine Letters

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Cardinale, B.J., D.S. Srivastava, J.E. Duffy, J.P. Wright, A.L. Downing, M. Sankaran, and C. Jouseau	2006	Effects of biodiversity on the functioning of trophic groups and ecosystems	Journal Article	Nature

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Dau, C.P., P.L. Flint, and M.R. Petersen	2000	Distribution of recoveries of Stellar's eiders banded on the lower Alaska Peninsula, Alaska	Journal Article	Journal of Field Ornithology
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DCRA	2010	Community Information Summaries (CIS): Igiugig	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Iliamna	Web Page	Alaska Community Database
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Gibson, D.D. and B. Kessel	1989	Variation in the marbled godwit and description of an Alaska subspecies	Journal Article	The Condor
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Petrula, M.J. and T.C. Rothe	2003	Migration chronology, routes, and winter and summer range of Pacific flyway population lesser sandhill cranes	Government Document	ADFG, Division of Wildlife Conservation, Watefowl Program
Quinn, T.	2005	The behavior and ecology of Pacific salmon and trout	Book	American Fisheries Society and University of Washington Press

Quinn, T.P., S.M. Carlson, S.M. Gende, and H.B. Rich Jr.	2009	Transportation of Pacific salmon carcasses from streams to riparian forest by bears	Journal Article	Canadian Journal of Zoology
Ruthrauff, D.R., L.T. Tibbitts, R.E. Gill, and C.M. Handel	2007	Inventory of montane-nesting birds in Katmai and Lake Clark National Parks and Preserves	Government Document	NPS SWAN Inventory and Monitoring Program and USGS Alaska Science Center

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Smith, M.C.T. and T. Nord	1991	Draft report: wildlife reconnaissance assessment, Pebble Copper project	Report	Cominco Alaska Exploration
Stehn, R., R.M. Platte, P. Anderson, F. Broerman, T. Moran, K. Sowl, and K. Richardson	2006	Monitoring Black Scoter populations in Alaska, 2005	Journal Article	US Fish and Wildlife Service, Migratory Bird Management; Yukon Delta National Wildlife Refuge; Selawik National Wildlife Refuge; and Izembek National Wildlife Refuge
Stewart, I.J., S.M. Carlson, C.P. Boatright, G.B. Buck, and T.P. Quinn	2004	Site fidelity of spawning sockeye salmon (*Oncorhynchus nerka* W.) in the presence and absence of olfactory cues	Journal Article	Ecology of Freshwater Fish

Unrau, H.D.	1992	Lake Clark National Park and Preserve historic resource study	Government Document	NPS
USFWS (US Fish and Wildlife Service)	1994	Conservation plan for the Pacific walrus in Alaska	Government Document	US Fish and Wildlife Service, Marine Mammals Management
USFWS	2008	Marbled murrelet (*Brachyramphus marmoratus*) species information and	Journal Article	US Fish and Wildlife Service

USFWS	2010	Pacific walrus (*Odobenus rosmarus divergens*): Alaska stock	Journal Article	US Fish and Wildlife Service
USFWS	2010	National Wetlands Inventory Iliamna D-6	Map	USFWS
Valkenburg, P., R.A. Sellers, R.C. Squibb, J.D. Woolington, A.R. Aderman, and B.W. Dale	2003	Population dynamics of caribou herds in southwestern Alaska	Journal Article	Rangifer

Van Daele, L. and T.A. Boudreau	1992	Caribou use of the proposed Cominco Pebble Copper Mine Site, Iliamna Lake, Alaska	Government Document	ADFG, Division of Wildlife Conservation
Van Daele, L.	1994	Status and seasonal movement of caribou near the Cominco Pebble Copper Mine Site, Southwest Alaska, 1992-1993	Government Document	ADFG, Division of Wildlife Conservation

Van Daele, L., J.R. Morgart, M.T. Hinkes, S.D. Kovach, J.W. Denton, and R.H. Kaycon	2001	Grizzlies, Eskimos, and biologists: cross-cultural bear management in Southwest Alaska	Journal Article	Ursus
Wentworth, C.	2007	Subsistence migratory bird harvest survey, Bristol Bay 2001-2005	Government Document	US Fish and Wildlife Service, Migratory Birds and State Programs; Togiak National Wildlife Refuge; and BBNA
Wilk, R.J.	1988	Distribution, abundance, population structure and productivity of tundra swans in Bristol Bay, Alaska	Journal Article	Arctic

Willson, M.F. and K.C. Halupka	1995	Anadromous fish as a keystone species in vertebrate communites	Journal Article	Conservation Biology
Willson, M.F., S.M. Gende, and B.H. Marston	1998	Fishes and the forest: expanding perspectives on fish-wildlife interactions	Journal Article	BioScience
Withrow, D.E. and K.M. Yano	2008	Recent counts of freshwater seals in Alaska's Lake Iliamna	Poster	NOAA NMFS, Alaska Fisheries Science Center, National Marine Mammal Laboratory

Zender Environmental Science and Planning Services	2006	Fecal coliform and water quality assessment of the Lower Nushagak River	Report	Alaska Soil and Water Conservation District and BBNA
Zender Environmental Science and Planning Services	2007	Continuation of fecal coliform and water quality assessment of the Lower Nushagak River (Year 2: data collection, analysis, and report)	Report	BBNA

Pages (and Volume(issue) if applicable)	Abstract
272	None
348	None
316	

352	None
256	None
696	None
194	The Bristol Bay critical habitat areas (CHAs) are co-managed by the Alaska Department of Fish and Game (ADFG) in accordance with Alaska Statute 16.20.520-530, and the Alaska Department of Natural Resources (DNR) per AS 38.05. The purpose of the Bristol Bay Critical Habitat Areas Management Plan is to provide consistent, long-range guidance in managing the five CHAs. ADFG has undertaken this comprehensive planning process in order to establish guidelines, policies, and regulations for management of fish and wildlife, habitat, and current and future activities that affect them on the CHAs. This draft plan presents management goals for the CHAs and their resources, and identifies polices to be used in determining whether proposed activities are compatible with the protection of fish and wildlife, their habitats, and public use of the CHAs. The goals and policies of this plan are adopted as regulation. The plan does not address hunting or fishing regulations, which are the purview of the Alaska Boards of Fish and Game.

149	This plan guides state land management by the Department of Natural Resources in the Nushagak and Mulchatna drainages and guides coastal consistency review. This plan: 1) identifies goals, management intent, and public use sites for 25 management units in the planning area; 2) specifies management policies for long-term uses (uses that take place at one site on state land for longer than 14 consecutive days), including permanent and temporary facilities, trapping cabins, boat storage, airstrip development, docks, and other uses, and specifies where these uses may be allowed and where they are prohibited; 3) includes guidelines that provide specific management direction for the 25 management units and public use sites; and 4) includes implementation information and recommendations for future management of the planning area. This plan is consistent with the goals and guidelines of the Bristol Bay Area Plan and the Bristol Bay Coastal Management Plan.
92	Alaska's immense size and northerly position make it a critical region for breeding and migrating shorebirds. In fact, Alaska provides breeding habitat for more shorebird species than any other state in the US. Seventy-three species of shorebirds have occurred in Alaska; 37 of them, including several unique Beringian species and Old World subspecies, regularly breed in the region. Most of these species migrate south of the US-Mexico border and one-third migrate to South America or Oceania. Concentrations of shorebirds at several coastal staging and migratory stopover sites exceed one million birds; on the Copper River Delta alone, five to eight million shorebirds stop to forage and rest each spring. Shorebirds worldwide have suffered dramatic population declines in the last decade. Using the species prioritization process developed for the US National Shorebird Plan, we incorporated new population estimates, updated threats, and identified 20 taxa of shorebirds of high conservation concern in Alaska. All species of concern tend to have small global population sizes or limited breeding distributions. Seasonal occurrence of priority species was examined within the geographic context of Alaska's five Bird Conservation Regions (BCRs). Most priority species, particularly breeding species, occur in the Western Alaska and Arctic Coastal Plain BCRs. Southern regions of the Northwest Interior Forest and the Northern Pacific Rainforest BCRs are primarily used by shorebirds during migration and winter. The Aleutian/Bering Sea Islands BCR is also an important wintering area for shorebirds. Around the world, loss of wetland habitat represents the greatest threat to shorebird populations. Nonbreeding and migratory stopover areas outside of Alaska that are important to the state's shorebirds are being altered by humans at an immense scale, primarily through drainage and reclamation of coastal wetlands. Critical shorebird habitats are further threatened worldwide by changes predicted to occur through ancillary effects of global climate change, particularly rising of sea level and drying of continental wetlands. Shorebird habitats in Alaska are still relatively intact, but interior wetlands important for breeding are already showing evidence of drying, and coastal areas are being altered by increasingly intense storms. Shorebird habitats in Alaska face other, more local threats, particularly from energy and mining development in the Cook Inlet, Northern Pacific Rainforest, and Arctic Coastal Plain regions. The Alaska Shorebird Conservation Plan is one of eleven regional plans associated with the US Shorebird Conservation Plan. This document is the second iteration for Alaska, and contains updated conservation objectives and priorities based on the latest information. Important changes in this version include updated species conservation scores, revised population estimates, updated descriptions of conservation threats in Alaska, and a new framework for building a conservation strategy within a landscape context

74: 416-422	Bristol Bay and its islands, the embayments, lagoons, and other estuaries along the north side of the Alaska Peninsula, and the nesting cliffs on the north shore, are seasonally important to vast numbers of seabirds, waterfowl, and shorebirds that breed, summer, winter, or stopover there during migration. This productive southeast corner of the Bering Sea is also used by sea otters and several species of pinnipeds and cetaceans, and is the site of the worlds largest salmon fishery. Petroleum development is planned for this area and, judging from the past history of numerous oil spills in nearby Cook Inlet, could have deleterious effects on this rich fauna. This possibility prompted investigations of the migratory birds, including the pelagic species, that could provide the year-round information on distribution and numbers necessary to protect birds from the possible hazards of petroleum development and shipping. A part of that information is provided by the observations on distribution and relative numbers of pelagic birds made in a section of Bristol Bay during July and August 1969, and reported on in this paper. Data on pelagic birds from the Bering Sea region is limited, and even less is published about birds within Bristol Bay. Jaques (1930) provided annotations on the birds he observed in and between Unalaska and Port Moller during the early summer of 1928. Shuntov (1961) surveyed populations of birds summering in the shallow portion of the eastern Bering Sea but west of Bristol Bay. King and McKnight (1969) made aerial surveys of the pelagic birds within 12 miles of the Bristol Bay coastline in October. Arnold (1948) reported on the distribution of birds in the North Pacific from Kodiak Island to Unalaska Island and in the Bering Sea from Unalaska Island to Attu Island between 18 June and 16 September 1944. Kuroda (1955) reported on the birds seen at sea in the vicinity of the Kuril Islands and near the western end of the Aleutian Islands. Shuntov (1966) and Irving et al. (1970) reported on the wintering birds of the Bering Sea. Unanalyzed data on birds observed in the Bering Sea are published with the oceanographic and fisheries records of the RV Osharo Maru (Hokkaido University 1957-68). Osgood (1904), Murie (1959), and Gabrielson and Lincoln (1959) summarized the information on birds of the lands bordering Bristol Bay. Dall (1873) and Cahn (1947) described the birds on and about Unalaska Island, the westernmost point included within our area of study. Except for Turner's (1886) brief account of the birds of Cape Newenham and recent unpublished data, the immense bird colonies along the western half of the north shore of Bristol Bay, including Cape Newenham and nearby islands, and the Walrus Islands (not to be confused with the Walrus Island of the Pribilofs) have been neglected by ornithologists and are not yet described. Gabrielson and Lincoln (1959) referenced only Turner's cursory account of Cape Newenham and were aware of small colonies on Hagemiester Island, but they, Murie (1959), nor Osgood (1904) were
25: 293-299	A reconnaissance sidescan sonar survey in Bristol Bay, Alaska revealed extensive areas of seafloor with features related to walrus foraging. They are similar to those seen in areas such as the outer Bering Sea and Chukchi Sea. Two types of feature were observed: (a) small (<<1 m diameter) shallow pits, often in clusters ranging in density from 5 pits per hectare to 35 pits per hectare; and, (b) more abundant, narrow, sinuous furrows, typically 5 to 10 m long with some reaching 20 m or more. Most foraging marks were in less than 60 m water depth in areas of sandy seafloor that were smooth, hummocky or characterized by degraded bedforms; the absence of foraging marks in other areas may be related, in part, to their more dynamic nature. The distribution of foraging marks was consistent in a general way with walrus locations from satellite telemetry studies.

12	In December 1991, Cominco Alaska Exploration (the former lease holder of the site now held by the Pebble Limited Partnership) contracted the Alaska Department of Fish Game (ADFG), Division of Wildlife Conservation, to investigate wildlife use and harvest in the proposed Pebble Copper Mine Area, northwest of Iliamna Lake, Alaska. This paper is a compilation of information from: 1) recent moose and bear surveys conducted per the agreement between the ADFG and Cominco Exploration; 2) bear, moose, and furbearers harvest data from 1985/86 - 1990/91; 3) historic aerial survey observations documenting bear use of salmon streams; and, 4) historic trend area counts for moose. Harvest data from the proposed mine area was taken from the Uniform Coding Units (UCU) which include the drainages of Kaskanak Creek (09b-0203), Talarik Creeks (09b-0302), the Chulitna River and Nikabuna Lakes (09b-0701), and the lower Mulchatna River from the confluence with the Koktuli River to the confluence of the Nushagak River (17b-0201) (Figure 1). This report summarizes the results of the investigation. It does not speculate on the possible impacts on bear, moose, and furbearers of the proposed mine or associated facilities, nor does it offer any mitigation options for the proposed developments.
8	None
443(26): 989-992	Over the past decade, accelerating rates of species extinction have prompted an increasing number of studies to reduce species diversity experimentally and examine how this alters the efficiency by which communities capture resources and convert those into biomass. So far, the generality of patterns and processes observed in individual studies have been the subjects of considerable debate. Here we present a formal meta-analysis of studies that have experimentally manipulated species diversity to examine how it affects the functioning of numerous trophic groups in multiple types of ecosystem. We show that the average effect of decreasing species richness is to decrease the abundance or biomass of the focal trophic group, leading to less complete depletion of resources used by that group. At the same time, analyses reveal that the standing stock of, and resource depletion by, the most species-rich polyculture tends to be no different from that of the single most productive species used in an experiment. Of the known mechanisms that might explain these trends, results are most consistent with what is called the 'sampling effect', which occurs when diverse communities are more likely to contain and become dominated by the most productive species. Whether this mechanism is widespread in natural communities is currently controversial. Patterns we report are remarkably consistent for four different trophic groups (producers, herbivores, detritivores and predators) and two major ecosystem types (aquatic and terrestrial). Collectively, our analyses suggest that the average species loss does indeed affect the functioning of a wide variety of organisms and ecosystems, but the magnitude of these effects is ultimately determined by the identity of species that are going extinct.

24(10): 6-15	Pacific salmon and other anadromous salmonids represent a major vector for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Salmon carcasses provide nutrients and energy to biota within aquatic and terrestrial ecosystems through various pathways. In this paper we review and synthesize the growing number of studies documenting this process in different localities. We also discuss the implications for maintaining the nutrient feedback system. Our findings show that future management will need to view spawning salmon and their carcasses as important habitat components for sustaining the production of fish as well as other salmon-dependent species within watersheds.
34	This report details the inventory of mammals in Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003 as part of a cooperative effort of the Beringian Coevolution Project at the Museum of Southwestern Biology, University of New Mexico and the Inventory and Monitoring Program of the National Park Service of Alaska. We begin the process of documenting the approximately 36 species of mammals that occur in the Park, with a primary focus on small mammals (i.e., shrews, voles, lemmings, weasels, porcupine, squirrels, and hares). This survey resulted in 856 primary specimens comprising 17 species. Across all localities sampled, two shrews (*Sorex cinereus, S. monticolus*) and a murid rodent (*Clethrionomys rutilus*) were the most frequently captured species, comprising over 85% of all mammals sampled. The discovery of singing vole (*Microtus miurus*) at Turquoise Lake constitutes a new mammal for the park and a major range extension for the species. This inventory also provided the first documented records in LACL of pygmy shrew (Sorex hoyi), montane shrew (*Sorex monticolus*), tundra shrew (*Sorex tundrensis*), little brown bat (*Myotis lucifugus*), and ermine (*Mustela erminea*). Two tiny shrews (*Sorex yukonicus*) collected at Turner Bay are only the second record of this rare species in the park and constitutes the latest additions to the 37 specimens now known to science. The findings from this study, when combined with specimen information gathered from a review of holdings at the University of Alaska Museum and other major collections, bring the total number of documented small mammal species in LACL to 18 of 22 probable species, or 82% coverage. The specific products of this inventory include a large collection of well-prepared, well documented, and diverse preparations of mammal specimens and associated materials (tissues, parasites, fecal samples, digestive tracts) for taxonomic, zoogeographic, ecological, genetic, parasitological, epidemiological, and other research and management purposes.

16(1): 28-45	Between 1991 and 1993, Alaska harbor porpoise (*Phocoena phocoena*) abundance was investigated during aerial surveys throughout much of the coastal and offshore waters from Bristol Bay in the eastern Bering Sea to Dixon Entrance in Southeast Alaska. Line-transect methodology was used, and only those observations made during optimal conditions were analyzed. Survey data indicated densities of 4.48 groups/100 km^2, or approximately 3,531 harbor porpoises (95% C.I. 2,206-5,651) in Bristol Bay and 0.54 groups/100 km^2, or 136 harbor porpoises (95% C.I. 11-1,645) for Cook Inlet. Efforts off Kodiak Island resulted in densities of 1.85 groups/l00 km^2, or an abundance estimate of 740 (95% C.I. 259-2,115). Surveys off the south side of the Alaska Peninsula found densities of 2.03 groups/100 km^2 and an abundance estimate of 551 (95% C.I. 423-719). Surveys of offshore waters from Prince William Sound to Dixon Entrance yielded densities of 4.02 groups/100 km^2 and an abundance estimate of 3,982 (95% C.I. 2,567-6,177). Combining all years and areas yielded an uncorrected density estimate of 3.82 porpoises per 100 km^2, resulting in an abundance estimate of 8,940 porpoises (CV = 13.8%) with a 95% confidence interval of 6,746-11,848. Using correction factors from other studies to adjust for animals missed by observers, the total number of Alaska harbor porpoises is probably three times this number.
71(3): 541-548	Molting adult Stellar's Eiders (*Polysticta stellari*) were banded at Izembek Lagoon (1961-1998) and Nelson Lagoon (1995-1997) along the lower Alaska Peninsula to determine breeding distribution and movements. Of 52,985 Stellar's Eiders banded, 347 were recovered. The overall low recovery rate may not be indicative of harvest levels but may be due to low reporting rates of bands. Almost all recoveries during summer were from Russia and recovery rates did not vary between sexes. We found no evidence that Stellar's Eiders molting in specific locations were more likely to be recovered in specific geographic locations in Russia. Our recoveries suggest that Stellar's Eiders molting along the Alaska Peninsula were from Russian breeding sites and from remnant breeding populations in Alaska.
17	The 29th consecutive spring aerial emperor goose survey was conducted from 1-3 May. The survey area is coastline and estuarine habitats from Jacksmith Bay to Wide Bay, including the north and south sides of the Alaska Peninsula. A total of 91,948 emperor geese were observed, up 41.6% from 2008 and up 43.2% from the long-term average (64,190, 1981-2008). This is the second largest count since the survey began bringing the recent 3-year average management index to 78,144 birds (up 7.2% from the previous 3-yr average of 72,864). Other species of emphasis included Pacific brant and Steller's eider with observed populations of 82,709 and 25,841, respectively. An amphibious Cessna 206 (N234JB) was used, flown at 45m (150 feet) ASL and 200km/hr (110 kts).
3	None

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310	Information about the red salmon runs and the spawning streams and beaches in the Kvichak River System, Bristol Bay, Alaska, is cataloged in this volume. The material is compiled from data obtained from spawning ground surveys made in the area since 1955 by the Fisheries Research Institute of the University of Washington. Earlier work was financed by the salmon canners of Bristol Bay. In recent years the work was supported by the Bureau of Commercial Fisheries. For each spawning stream or beach, the catalog gives, whenever available, the stream catalog number, name, location, and physical description, including dimensions, bottom quality, flow barriers, watershed size and type, vegetation, gradient, water velocity, estimated flow, air and water temperature, and general information including shelter, survey routes and methods, personal-use fisheries, and wildlife species. Then a description of red salmon runs to the area is listed, including magnitude of the run and timing and distribution of spawning. Estimates of numbers of red salmon to each stream or beach are listed chronologically under a separate entry entitled "Summary of Surveys."
35-44	This paper provides an estimate of the economic value of wild salmon ecosystems in the major watershed of Bristol Bay, Alaska. The analysis utilizes both regional economic and social benefit-cost accounting frameworks. Key sectors analyzed include subsistence, commercial fishing, sport fishing, hunting, and nonconsumptive wildlife viewing and tourism. The mixed cash-subsistence economy of Bristol Bay supports a population of 7,611 (2000 census) that is 67 percent Alaska Native. Estimated expenditures and net economic values for all sectors were based on a literature review and available data, with the exception that original data was collected for 2005 on the sport fish sector using a random sample of licensed Alaska anglers. Methods included use of a regional input-output model maintained at the University of Alaska, and survey research and contingent valuation methods for the sport fishermen. Potential respondents included 886 resident anglers and 1,514 nonresident anglers contacted through a mail/internet approach. Additionally, 300 licensed anglers, 330 clients of Bristol Bay fishing lodges, and 46 lodge owners were contacted through a mail survey. Response rates ranged from 25.6 percent for resident anglers to 44.1 percent for nonresidents. Estimated direct expenditures/sales were \$234.4 million in 2005 for commercial fishing and processing, \$61 million for sport fishing, \$17.1 million for wildlife viewing, \$7.2 million for subsistence-related expenditures, and \$12.4 million for sport hunting. Nearly 100 percent of the private basic sector in Bristol Bay and 5,540 full-time equivalent jobs are supported by this \$324 million estimated direct economic impact associated with wild salmon ecosystem services. Direct net economic values are estimated at \$104 million to \$179 million per year, and are primarily associated with the subsistence sector.

113(4): 889-901	We studied the migration and winter distribution of adult Greater Whitefronted Geese (Anser alibfrons frontalis) radio-marked on the Yukon Kuskokwim Delta (YKD) and Bristol Bay Lowlands (BBL) of Alaska from 1987 to 1992. The major autumn staging site for geese from both breeding areas was the Klamath Basin on the California/Oregon border. However, temporal use of this area differed markedly between populations. Geese from the BBL arrived at the Klamath Basin nearly 30 days before geese from the YKD and departed before most YKD geese had arrived. Ninety percent of BBL geese used the Klamath Basin in autumn, whereas 30% of YKD geese bypassed the Klamath Basin during autumn and instead flew directly to the Central Valley of California. Nearly all BBL geese migrated directly from the Klamath Basin to wintering areas in Mexico, bypassing the Central Valley. Ninety percent of the BBL geese wintered in Mexico, as opposed to <20% of the YKD geese. Wetlands of the Interior Highlands in the state of Chihuahua, particularly Laguna Babicora, were used by >90% of the radio-marked geese in Mexico. Marshes along the West Coast comprised the other important wintering habitat in Mexico. The Sacramento Valley of California was the predominant wintering area for YKD geese. BBL geese migrated north from Mexico into the San Joaquin Valley or Sacramento-San Joaquin Delta of California by the last week of January. Fifty-five percent of the BBL population used the Klamath Basin in spring, but many birds staged in eastern Oregon and western Idaho. In contrast, geese from the YKD staged almost exclusively in the Klamath Basin during spring before flying to staging areas in Alaska. Breeding allopatry and temporal partitioning on staging and wintering areas likely has contributed to the evolution of previously described phenotypic differences between these populations. These two populations, along with the Tule Greater White-fronted Goose (A. a. gambeli), may constitute a portion of a Rassenkreis, a group of subspecies connected by clines, each ecotype of which has independent conservation needs.
54(4): 281-288	Between June 1975 and June 1977, five aerial surveys were conducted along the eastern Aleutian Islands and throughout Bristol Bay to study the distribution and abundance of the harbor seal (*Phoca vitulina richardsi*) during the breeding season. The number of group sightings and the total number of seals observed varied significantly with the tide height ($P<0.01$). Fifty-seven percent more seals were observed on a low tide than in the same area surveyed near high tide. Three locations-Port Moller, Port Heiden, and Cinder River along the north side of the Alaska Peninsula accounted for 78 percent of the study area population count, and for approximately 8.5 percent of the entire Alaska population estimate. A minimum abundance for the study area is estimated at 29,000 animals.
27(2): 68-92	Since 1980, the Division of Subsistence of the Alaska Department of Fish and Game has conducted research on contemporary hunting, fishing, and gathering in Alaska Native and other rural Alaska communities. This paper describes the division's research program and some the results of the division's studies. First, there is an overview of the state and federal legislation which provides a preference for subsistence uses in resource management and allocation decisions. Next, the division's research methods are discussed, followed by a summary of some of the recent findings about the role of subsistence uses in the mixed subsistence-based economies of Alaskan villages. A description of a "baseline" study in the Central Yup'ik Eskimo village of Manokotak illustrates the kinds of information which the division has collected for about 151 communities. The paper also illustrates how these data have been applied in resource management decisions. In conclusion, the paper speculates about the future of the program in light of court decisions which may eliminate the legal protections which have pertained to subsistence uses in Alaska since 1978.

405	This report presents updated information about subsistence uses of fish, wildlife, and plant resources in 5 communities of southcentral Alaska -- Iliamna, Newhalen, Nondalton, Pedro Bay, and Port Alsworth. The Division of Subsistence of the Alaska Department of Fish and Game conducted the study in collaboration with the National Park Service and Stephen R. Braund & Associates. The Pebble Project is a proposed open pit mine located 18 miles to the northwest of Iliamna and 18 miles southwest of Nondalton. The potential development of the mine requires updated baseline information about subsistence harvests and uses. Information was collected through systematic household surveys and mapping interviews. Scoping meetings were held in each community to elicit ideas about research questions and to learn more about issues. After preliminary study findings were available, a second round of community meetings took place to review the results. In total, 116 households were interviewed, 79% of the year-round resident households. The study documented the continuing importance of subsistence hunting, fishing, and gathering to the study communities. In 2004, virtually every person in each community participated in subsistence activities and used wild resources. Subsistence harvests were large and diverse. Estimated wild resource harvests were 469 pounds usable weight per person in Iliamna, 692 pounds per person in Newhalen, 358 pounds per person in Nondalton, 306 pounds per person in Pedro Bay, and 133 pounds per person in Port Alsworth. Most participants in this study reported their subsistence uses and harvests have changed in their lifetimes and over the last 5 years, due to reduced resource populations, shifts in the locations of moose and caribou, competition with nonlocal sport hunters, and a warming climate. Residents voiced concerns about the potential development of a mine and the construction of a road through and near their traditional subsistence harvest areas.
44	None

235	This final report presents the results of an ethnographic project that investigated how families in 4 communities of the Kvichak District of the Bristol Bay Management Area of Southwest Alaska develop subsistence fishing strategies, such as when to fish, where to fish, who to fish with, and how much to harvest, in response to changing sociocultural, economic, and environmental circumstances. Research methods included participant observation at fish camps, key respondent interviews, family case studies, and systematic household surveys. This report describes case examples of summer subsistence fishing for sockeye salmon *Oncorhynchus nerka*, examples of subsistence fishing in the fall for spawning sockeye salmon, and a review of the use of seine nets as a subsistence sockeye salmon fishing method at Nondalton. The report concludes that the subsistence fishery is vital to the way of life of the study communities, and is accomplished in an efficient and sustainable manner informed by traditional knowledge. Annual and long term variations in the fishery are shaped by a complex set of environmental, economic, cultural, and personal factors. Also, findings based on household surveys and permit returns suggest that relying solely on permit returns results in an underestimate of subsistence sockeye salmon harvests. Additional outreach is necessary to encourage households to obtain permits and keep accurate records of their harvests.
52(10): 917-928	Because of the burgeoning interest in salmon, growing indications of their ecological importance, and recent calls for management to consider the role of salmon in aquatic and terrestrial ecosystems (e.g., Larkin and Slaney 1997), we take this opportunity to review what is understood about the function of salmon as key elements of ecological systems. Our objectives are twofold. First, we expand on previous reviews of salmon (Willson et al. 1998, Cederholm et al. 1999) to include recent research that has amplified and modified earlier ideas about the contribution of salmon to ecosystem processes. In doing so, we describe the composition, magnitude, and distribution of marine inputs to freshwater and terrestrial systems via salmon. We use an expanding group of studies pertaining to stream nutrient budgets and salmon physiology to construct a schematic that illustrates salmon-derived products and the pathways by which they enter and are retained in aquatic and terrestrial food webs. We then consider the ecological variation associated with salmonid ecosystems and how this may influence the ecological response to the salmon input. Second, we consider how this variation in ecosystem response may influence management and conservation efforts. We conclude by suggesting new research directions to help fill the gaps in our current understanding of salmonid ecosystems.

91(2): 436-443	There are three breeding populations of the Marbled Godwit *Limosa fedoa* (Linnaeus): the prairie-breeding birds of mid-continent North America, and widely separated tundra-breeding populations at James Bay, Canada, and in the vicinity of Ugashik Bay, Alaska, on the north coast of the Alaska Peninsula. The Alaska population, which apparently winters locally on the Pacific coast from Washington to northern California, comprises birds with shorter tarsi, shorter wings, shorter culmens, and more massive bodies than those of the mid-continent population. Believed to have persisted near Ugashik Bay since that area formed part of Pleistocene Beringia, the Alaska birds are described as a new subspecies *L. f. beringiae*.
13(2): 68-75	Understanding changes in spatial and temporal patterns of harvest is vital for proper management of wolverine *Gulo gulo* populations. In Alaska, wolverines occupy nearly all areas of the state and are classified as furbearers and big game, with annual harvests averaging 545 (SD = 80) individuals since 1984. Because wolverine reproductive potential and survivorship are relatively low, it is important to understand spatial and temporal harvest dynamics to ensure populations are not overharvested. We analyzed the effects of geographic region, time period and number of harvesters on wolverine harvest using Poisson regression modeling. We also examined local harvest patterns for a portion of south-central Alaska where human population levels and concentrations of roadways differ substantially. Patterns of wolverine harvest during 1984-2003 indicated consistently higher harvest densities (wolverines/1,000 sq.-km) in the southern portion of Alaska. The Poisson regression model (goodness of fit: Chi-square = 1300, df = 1288, P = 0.60) estimated mean annual harvest levels (wolverines/1,000 sq.-km) that were higher in South-central (0.35) than in Arctic/West (0.11; P = 0.009) and Interior (0.19; P = 0.001), but no other regional comparisons were significant. Geographic region, time period and number of harvesters were all significant covariates for describing wolverine harvest (P < 0.001 for each). Wolverine harvest densities at the local level indicated that areas with higher harvest densities were well distributed, but that areas with light or no reported harvest also were common and widespread. Our results also indicated that proximity to human population centers or roadways did not necessarily affect harvest densities at a local level. We reviewed the importance of areas with no or light harvest as potential refugia to maintain a sustainable harvest of wolverines.

450	Sport anglers reeling in salmon, halibut, and other fish generated--both directly and indirectly--an estimated three percent of jobs and payroll in Alaska in 1993. This is one of the findings of a study of the economics of sport fishing that ISER did for the Alaska Department of Fish and Game. Sport fishing is enormously popular with residents and visitors. The Department of Fish and Game estimates that nearly half a million anglers fished in Alaska in 1997, with numbers of visiting anglers slightly edging Alaskan anglers. Seven out of ten Alaska households have at least one sport angler. Nearly half of Alaska's households rate hunting and fishing opportunities as important reasons why they live where they do. The department contracted with ISER to do this study because the economics of sport fishing in Alaska is an important consideration for resource managers allocating fish stocks, evaluating fishery projects, and making decisions about land and water management. The analysis is based largely on information we collected in surveys of sport anglers and guide and charter businesses in 1993 and 1994. It's not entirely clear how sport fishing has changed since 1993. The Department of Fish and Game reports that the number of resident licenses stayed roughly the same, while the number issued to nonresidents grew about 25 percent. But at the same time, the department also reports that measures of fishing pressure-angler-days fished and numbers of fishing trips--have not changed substantially since 1993. There is some evidence that the growing number of visiting anglers may be mostly casual anglers, who fish once or twice while they're in Alaska. Numbers of sport charters operating in Southcentral and Southeast Alaska increased sharply in the 1990s, and many customers of those charters are tourists who buy single-day licenses. So the overall economic contribution of sport fishing may not have changed substantially since our survey. In any case, patterns of sport fishing--what people buy for sport fishing and how they travel to sport fishing locations, for instance--don't change quickly. We believe the broad picture of the economics of sport fishing in Alaska that we present here is valid. Below we first describe how we assessed the economics of sport fishing, then profile resident and visiting sport anglers, and conclude with our estimates of the economic value of sport fishing and its contribution to the economy.

20	The freshwater streams of the Bristol Bay drainages support important subsistence and commercial salmon fisheries and internationally-famous sport fisheries for both resident species and salmon. Northern Dynasty Mines, Inc. (NDM) has proposed to mine a metallic sulfide deposit at the headwaters of some of these streams. The project, referred to as Pebble Mine, will have a preliminary lifespan of 40 to 50 years, or even longer. Applications filed by NDM in 2006 indicate that the proposed project will leave permanent landscape features affecting some thirty square miles, including two tailings ponds that will house billions of tons of mine tailings which will include toxic materials. The project will also include a 104-mile access road, with a slurry line and a water line that will directly affect at least 12.5 square miles and a power transmission line. The 2006 applications help identify potential impacts on the fish habitat and fisheries. Categories of these potential impacts of Pebble Mine on fish habitat and fishery resources include: direct, indirect, and cumulative effects. Direct impacts will result from the approximately 30 square mile footprint of the mine, processing plant, and tailings ponds; more than 60 lineal miles of mainstem streams--plus the adjacent tributaries and wetlands--that will be totally or partially dewatered; the 12.5 square miles or 8,000 acres of disturbance from the access road; port facilities; and, power production and power supply lines. Siltation caused by road-building activities will smother fish food organisms and incubating eggs and alevins. Direct effects associated with the road also include fragmentation of aquatic, riparian, and terrestrial habitats. Indirect impacts will include increased pressure on, and competition for, fish and wildlife resources, because of the increased access to the area and increased population. Cumulative impacts will include long-term, multi-year losses of fish production and stream productivity. Over time, bridges and culverts in the access road can deteriorate and interfere with juvenile or adult fish migration between important habitats. Dust and silt from the road during the life of the project or leakage from the slurry line may smother fish food organisms and incubating fish eggs and could wash downstream to affect spawning and rearing habitat in Iliamna Lake. In addition, the weight of the roadbed and traffic can be expected to compact the soil and alter the movement of groundwater which could disrupt beach spawning by sockeye salmon in Iliamna Lake. Although the access road and other support roads will be constructed for the proposed Pebble Mine, they will also provide access to the area by other residential, commercial, and recreational users. The human population and activities can be expected to increase, and off road, all terrain vehicle use will expand into areas not previously accessible. The impact will extend much beyond the footprint of the road itself. Any real or perceived impact from the proposed Pebble Mine on Bristol Bay salmon populations will have the probability of destroying the high-
34(3): 303-309	This study assessed the summer diet and consumption patterns of harbor seals (*Phoca vitulina*) resident in Iliamna Lake, Alaska. The authors predicted that adult sockeye salmon (*Oncorhynchus nerka*), a seasonally abundant and nutrient-rich prey source, would dominate diets when available and that seals would preferentially consume the most energetically profitable portion of salmon carcasses. Diet was examined by identifying hard parts of prey found in harbor seal scats, and consumption patterns were measured by collecting carcasses of harbor seal-killed sockeye salmon along island spawning grounds. Salmonids were present in 98% of scats that contained identifiable prey, followed by petromyzontids, osmerids, cottids, coregonids, and gasterosterids. The carcass surveys provided evidence of selective consumption patterns of sockeye salmon body parts. Harbor seals consumed the bodies of nearly all (96.6%) male salmon collected, leaving little but the head. In contrast, the belly and eggs were consumed in 63.6% of the female samples, and the entire body was eaten in only 31.3% of females. The harbor seals in Iliamna Lake thus took advantage of the seasonally abundant adult sockeye salmon by consuming them selectively and as a high proportion of their diet, but they also consumed smaller resident fishes, which presumably sustain them during the rest of the year.

121(4): 546-550	We quantified the amount, spatial distribution, and importance of salmon *(Oncorhynchus* sp.)-derived nitrogen (N) by brown bears (*Ursus arctos*) on the Kenai Peninsula, Alaska. We tested and confirmed the hypothesis that the stable isotope signature (δ15N) of N in foliage of white spruce (*Picea glauca*) was inversely proportional to the distance from salmon-spawning streams ($r=-0.99$ and $P<0.05$ in two separate watersheds). Locations of radio-collared brown bears, relative to their distance from a stream, were highly correlated with δ15N depletion of foliage across the same gradient ($r=-0.98$ and -0.96 and $P<0.05$ in the same two separate watersheds). Mean rates of redistribution of salmon-derived N by adult female brown bears were 37.2 ± 2.9 kg/year per bear (range 23.1-56.3), of which 96% (35.7 ± 2.7 kg/year per bear) was excreted in urine, 3% (1.1±0.1 kg/year per bear) was excreted in feces, and <1% (0.3 ± 0.1 kg/year per bear) was retained in the body. On an area basis, salmon-N redistribution rates were as high as 5.1 ± 0.7 mg/sq.-m per year per bear within 500 m of the stream but dropped off greatly with increasing distance. We estimated that 15.5-17.8% of the total N in spruce foliage within 500 m of the stream was derived from salmon. Of that, bears had distributed 83-84%. Thus, brown bears can be an important vector of salmon-derived N into riparian ecosystems, but their effects are highly variable spatially and a function of bear density.
69(3): 1147-1162	A large barren-ground caribou (*Rangifer tarandus granti*) population (the Bering Seacoast Herd) historically ranged across southwest Alaska. The size of this herd peaked in the early 1860s but declined by the late 1880s. Caribou numbers remained low in southwest Alaska for the next 100 years. Biologists have argued that periodic dispersal has been an important factor in caribou population dynamics. However, others conclude there was no credible evidence that significant interchange between herds has ever occurred in Alaska. Since 1981, we monitored 318 radiocollared caribou and documented dramatic population growth, erratic movements, shifts from traditional ranges, and changes in migratory behavior. We also documented shifts in calving distribution that may contrast with conventional concepts of calving tradition and herd identity. Some biologists have concluded caribou herds can be considered closed populations for management purposes because the number of dispersing caribou is so small that it has no influence on population dynamics. We propose that the current definition of a herd may be appropriate for short-term management; however, over long time frames and large spatial scales, metapopulations may better describe caribou ecology and be more useful in long-term caribou conservation.

184	The goal of this project was to estimate harvests of caribou (primarily the Mulchatna and Nushagak Peninsula herds), moose, black bear, brown bear, and Dall sheep (collectively identified as "large land mammals" in this report) by residents of the communities of the western Bristol Bay Area in Game Management Units (GMU) 9B and 17 (Figure 1). The research was modeled after the Northern Alaska Peninsula Large Land Mammal Project conducted jointly by the Division of Subsistence of the Alaska Department of Fish and Game (ADFG) and the Natural Resource Department of the Bristol Bay Native Association (BBNA) (Krieg et al. 1996, Krieg et al. 1998). This project was also conducted by ADFG and BBNA. It was funded through a cooperative agreement with the US Fish and Wildlife Service (FWS Agreement Number 701811J3557; ADF&G Number COOP 01-073). Using local research assistants hired by BBNA, household interviews were conducted to collect harvest and use information for large land mammals. Hunters also mapped areas used to hunt and harvest these species. Study communities were Aleknagik, Clarks Point, Dillingham, Ekwok, Igiugig, Iliamna, Kokhanok, Koliganek, Levelock, Manokotak, Newhalen, New Stuyahok, Nondalton, Pedro Bay, Portage Creek, Port Alsworth, Togiak, and Twin Hills (Figure 1). Key respondent interviews were also conducted in Unit 9B to document their traditional ecological knowledge (TEK) relating to harvest methods, and trends in both the environment and large land mammal populations. These interviews took place in the communities of Igiugig, Iliamna, Kokhanok, Newhalen, Nondalton, Pedro Bay, and Port Alsworth.
113(1): 81-101	Many explanations for diversity patterns have been proposed, and there have been several recent reviews of the subject (Pianka 1966, 1974; Ricklefs 1973; Pielou 1975). High diversity has been attributed both to intense competition which forces niche restriction (Dobzhansky 1950; MacArthur and Wilson 1967) and negatively correlated with productivity (Yount 1956; Margalef 1969). The question is far from settled. This paper develops an approach to the problem of species diversity based on the nonequilibrium interactions of competing populations. Under nonequilibrium conditions, differences in diversity are strongly influenced by variations in the rates of competitive displacement between communities, and such factors as relative competititve abilities, niche partitioning, etc., may not be particularly important. This approach deals primarily with the maintenance of diversity, as opposed to the generation of diversity. While most of the current diversity hypotheses have some relation to the evolutionary origin of diversity, this will not be emphasized here.
93(870): 145-159	None

17(3): 617-631	Pacific walruses (*Odobenzs rosmarzs divergens*) make trips from ice or land haul-out sites to forage for benthic prey. We describe dive and trip characteristics from time-depth recorder data collected over a one-month period during summer from four male Pacific walruses in Bristol Bay, Alaska. Dives were classified into four types. Shallow (4 m), short (2.7 min), square-shaped dives accounted for 11% of trip time, and many were probably associated with traveling. Shallow (2 m) and very short (0.5 min) dives composed only 1% of trip time. Deep (41 m), long (7.2 min), square-shaped dives accounted for 46% of trip time and were undoubtedly associated with benthic foraging. V-shaped dives ranged widely in depth, were of moderate duration (4.7 min), and composed 3% of trip time. These dives may have been associated with navigation or exploration of the seafloor for potential prey habitat. Surface intervals between dives were similar among dive types, and generally lasted 1-2 min. Total foraging time was strongly correlated with trip duration and there was no apparent diel pattern of diving in any dive type among animals. We found no correlation between dive duration and postdive surface interval within dive types, suggesting that diving occurred within aerobic dive limits. Trip duration varied considerably within and among walruses (0.3-9.4 d), and there was evidence that some of the very short trips were unrelated to foraging. Overall, walruses were in the water for 76.6% of the time, of which 60.3% was spent diving.
58(2): 192-202	Satellite radio-location data from 57 adult male Pacific walruses (*Odobenus rosmarus divergens*) were used to estimate haul-out fidelity, broadly describe seasonal foraging distributions, and determine the approximate timing of autumn migration from Bristol Bay, Alaska. Data were collected intermittently during 1987-91 and 1995-2000, primarily during the period from May to October. Transmitter longevity ranged from less than 1 day to 560 days (median 75 d). The four tagging sites were the only haul-outs that were commonly used in the bay from spring through autumn. Mean fidelity, defined as the chance that an animal will return to an area where it previously hauled out, was 0.56 (SE = 0.09). However, small sample sizes precluded comparisons of fidelity among years and among haul-outs by season. No tagged animals migrated out of the bay between spring and early autumn. Combined monthly locations suggest that foraging occurred primarily in the southern and eastern areas of the bay in spring and gradually shifted towards northwestern areas in late autumn and winter. Ninety-eight percent of the in-water locations were in waters under 60 m deep, which account for 76% of the study area. Some animals migrated out of the bay in late autumn and winter; others remained within the bay throughout the year. Those making long-range migrations departed the bay during November and December.
72(4): 537-546	To learn more about mid-Pacific migration, we radio-tagged 40 Pacific Golden-Plovers (*Pluvialis fulva*) in spring 1999 on their wintering territories in Hawaii. The birds departed in late April, and with aerial monitoring we relocated 10 of them in Alaska. Seven individuals were in or near the Nushagak River lowlands in southwestern Alaska. Nesting Pacific Golden-Plovers were discovered there in 1994 disjunct from the previously known breeding range. The remaining three radio-tagged birds were found north of Bethel on the Yukon-Kuskokwim Delta. Our results suggest that breeding is continuous from the Nushagak region west through the uplands north of Bristol Bay to the Yukon-Kuskokwim Delta. Thus plovers wintering in Hawaii apparently nest across a wide area of Alaska. We present a revised Alaska breeding distribution map for the species which differs significantly from AOU Checklist boundaries. The temporary attachment of transmitters (they are shed during summer molting) had no apparent effect on survival within our sample population. Birds that had carried transmitters returned to their winter territories in Hawaii at a rate nearly identical to banded plovers not radio-tagged.

138	None
26	Annual spring aerial surveys were initiated in 1992, and repeated in 1993, 1994, 1997, 1998, 2000-2005 and 2007 to monitor the population status of and habitat use by Steller's eiders (*Polysticta stelleri*) staging for spring migration in southwestern Alaska. Since the timing of migration varies, two to three replicate shoreline surveys were conducted each survey year through 1997, to target the optimal timing when most eiders were within the survey area prior to departure to arctic breeding grounds. Fiscal constraints and inclement weather in subsequent years resulted in successful completion of only one survey per year, the timing of which was carefully scheduled using sea ice, weather and observational data from local contacts. We made visual estimates of Steller's eiders and all other identifiable water birds and marine mammals along shorelines, estuaries and shoals where Steller's eiders and other seaducks were known to congregate during migration. In each year where multiple surveys were completed, the highest Steller's eider count was used as that year's population estimate for trend analysis. Annual Steller's eider raw counts are 137,904 (1992); 88,636 (1993); 107,589 (1994); 90,269 (1997), 84,459 (1998), 68,956 (2000), 58,231 (2001), 54,191 (2002), 77,329 (2003), 82,455 (2004), 79,022 (2005) and 87,353 (2007). The long-term average from 1992 to 2007 is 84,700. Correcting recent estimates using extrapolated data from sampled shoal habitats, the totals are 72,953 (2000), 60,656 (2001), 56,704 (2002), 77,369 (2003), 82,772 (2004), 79,022 (2005), and 87,400 (2007). We suspect that the low population estimates obtained from 2000 through 2002 were due in part to a portion of the eiders migrating northward during the survey, thus escaping detection by the survey crew. This hypothesis was supported by satellite telemetry data which indicated migration within the study area during the survey of 2002. We therefore initiated the 2003 through 2007 surveys in early April, encountering most eiders before they moved from Alaska Peninsula lagoons to Kuskokwim Bay and other more northerly habitats. Unexpanded long-term survey data indicate a 2.8 percent average annual decline in Steller's eiders using this migration corridor (R-squared = 0.30), but the estimated population trend has been level since 2002. Maps illustrate the distribution of Steller's eiders and other selected species within the survey area in 2007. A persistent pattern of habitat use by Steller's eiders and most other sea duck species among years indicates the importance of certain areas to staging and migrating waterfowl. Many of these areas are used heavily by molting and staging birds in the fall as well.

65	The purpose of this guide is to provide assistance to visitors to the Southwest Alaska Network (SWAN) national parks and National Park Service staff in identifying, understanding, and enjoying bivalves found in intertidal sediments in the SWAN parks. We have provided brief sections on the ecology of these clams, including comments on their habitats and feeding types, and a descriptive guide to the clams. The descriptive guide includes drawings and photographs to depict the appearance of the clams both in the hand and, where possible, the appearance of distinguishing indicators of their presence in the field. For each species, we have included a brief description of the clam, its typical habitat, and its distribution among the parks and in the North Pacific. Bivalves are a critical source of nutrition for major predators such as bears, sea otters, sea (diving) ducks, shorebirds and other invertebrates at some time during the year. For example, bears along the KATM coast achieve higher rates of energy from razor and softshell clams than those foraging on vegetation (Smith 2004). In addition to supporting the bears, sea otters, diving ducks, and shorebirds for millions of years, clams have been a major source of food for native Alaskans since their arrival in Alaska 15,000 to 20,000 years ago. They have been important in the success of native cultures in coastal environments. Clams exhibit longevity and lack of mobility, and thus are good indicators of long-term conditions (Bennett 2006). It can be assumed that beaches supporting reasonable numbers of longlived clams are stable and "healthy." This guide includes descriptions of twenty-nine species in thirteen families that were found in surveys of beaches in three SWAN national parks during the summers of 2004 and 2005 (Lees and Driskell 2004, 2006a, and 2006b). The parks surveyed were Katmai National Park and Preserve (KATM), Kenai Fjord National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). Species composition of the clams varied considerably by park. Approximately the same number of clam species was observed in KATM and KEFJ, but LACL supports far fewer species. Only Baltic macomas and softshell clams were found in all parks. In contrast, half the species were found only in KATM (7) or in KEFJ (7). The frequency with which the species occurred in the parks provides some indication of the likelihood that the clams or their shells will be encountered while examining park beaches. Many species were observed only rarely in one or more parks. Baltic macomas and foolish mussels were encountered far more frequently than any other species. The second tier for frequency of occurrence includes littleneck, butter, and softshell clams, oval macomas, and Arctic hiatellas.
10(3): 201-207	Thirty-eight aerial surveys of beluga or white whales (*Delphinapterus leucas*) were conducted in Bristol Bay, Alaska, during six different years between 1993 and 2005. Belugas were sighted mainly close to shore in the upper parts of Nushagak and Kvichak bays as well as along the coast between these bays and in the lower parts of major rivers. Data from 28 complete counts made in good or excellent survey conditions were analysed for trend. Counts ranged from 264 to 1,067. The estimated rate of increase over the 12-year period was 4.8%/year (95% CI = 2.1%-7.5%). Such a rate of increase suggests that either the population was below the environmental carrying capacity in the early 1990s or, alternatively, that factors that had been limiting population increase were alleviated after that time. A review of possible changes in human-caused mortality, predation and prey availability did not reveal a single likely cause of the increase. Among the factors that could have played it role are recovery from research kills in the 1960s, a modest decline in subsistence removals and a delayed response to increases in Pacific salmon (*Oncorhynchus* spp.) abundance in the 1980s. The positive growth rate for this population shows that in recent years there has been no substantial negative impact of human or natural factors, acting either alone or in combination, and there is no need for changes to the current management regime.

72: 102-105	None
6	This Draft Environmental Baseline Progress Report provides a description of the work conducted for the Northern Dynasty Mines Inc. (NDM) 2004 baseline environmental program. This Pebble Project progress report presents the characterization of the existing conditions related to environmental and social conditions of the project area and their incorporation into the project design and operation. This draft report is presented for agency and stakeholder review and comment, to ensure the approach followed and results obtained provides a comprehensive and thorough baseline environmental characterization of the Pebble Project.
806	This section discusses the groundwater sampling results from the 2004 field season. The data are analyzed to determine spatial (lateral and vertical) variations and variations with time. The data are also compared with surface water-quality criteria to provide a benchmark for water quality. Based on the results of this analysis, requirements for further data are noted. Groundwater samples were collected in September and October 2004. The study results will be included in the environmental baseline document and are expected to be used for both the design and the permit applications for construction, operation, and closure of the proposed mine. The objective of the following discussion is to report the progress of groundwater sampling and analysis and the current understanding of groundwater chemistry.
89	The purposes of these terrestrial wildlife and habitats studies were fourfold: to document the baseline (predevelopment) conditions; to assist in project design; to provide the basis for assessing effects of project development and mitigation; and to support permit applications. This progress report describes baseline studies of terrestrial wildlife and habitats in the mine study area and the associated road/port study area for the Pebble Project. Because the distinctive nature of species components (mammals, raptors, etc.), different study areas were used, tailored to each group. These study areas are shown on the respective figures for each species group. In the following discussion, each species component (mammals, raptors, etc.) at each location (mine site or road/port area) is addressed in a separate section (e.g., 9.1 is mammals at the mine site, while 9.6 is mammals at the road/port area). The exception is breeding birds, which were studied only at the mine site and are therefore addressed in a single section (9.4).
130	This section presents the preliminary findings of the 2004 marine wildlife study. This study examined the distribution and abundance of marine wildlife (marine-oriented birds and marine-oriented mammals) during two sampling periods in 2004: summer and late fall/winter. The surveys focused on threatened/endangered species (e.g., Steller's Eiders [*Polysticta stelleri*]), species being considered for listing under the Endangered Species Act (e.g., Kittlitz's Murrelet [*Brachyramphus brevirostris*]), depleted or rare species of marine mammals (e.g., beluga whales [*Delphinapterus leucas*], Steller sea lions [*Eumetopias jubatus*]), marine-oriented birds in general (including breeding species), and marine- oriented mammals.

94	None
15	None
378	Few subjects have generated as much emotional dialogue around conflicting scientific and policy agendas as the protection and management of Pacific salmon resources. In this major new work, esteemed fisheries expert Thomas Quinn distils from the vast scientific literature the essential information on the behaviour and ecology of Pacific salmon, including steelhead and cutthroat trout. Unlike other books that examine only selected life stages, habitats, or species, this book - richly illustrated with beautiful photographs and original drawings - thoroughly covers the complete life cycle, emphasizing common themes and differences among the various species of salmon. Representing the range of species and geographic regions, Quinn includes examples from classic studies by pioneers of salmon biology and from the most current research to illustrate the important features of salmon life history and behaviour and the complex physical, biological, and human factors that affect them. "The Behavior and Ecology of Pacific Salmon and Trout" introduces salmon and trout as a group, with a brief description of each species, and compares them to other fishes. This book then follows salmon on their amazing homeward migration from the open ocean, through the complex coastal waters, and upstream to the precise location where they were spawned years earlier. It explains the patterns of mate choice, the competition for nest sites, and the fate of the salmon after their death. It describes the lives of offspring during the months they spend incubating in gravel, growing in fresh water, and migrating out to sea to mature. Quinn emphasizes the importance of salmon to humans and to natural ecosystems and the need to integrate sound biology into conservation efforts. This thorough, up-to-date survey should be on the shelf of anyone with a professional or personal interest in Pacific salmon and trout. Written in a technically accurate but engaging style, it will appeal to a wide range of readers, including students, anglers, biologists, conservationists, legislators, and armchair naturalists.

87: 195-203	Predation on Pacific salmon by bears (genus *Ursus* L., 1758) can be an important ecosystem process because the spatial distribution of carcasses largely determines whether marine-derived nutrients cycle through aquatic or terrestrial pathways. Direct observations on three streams in southeastern Alaska indicated that 49% of the pink (*Oncorhynchus gorbuscha* (Walbaum, 1792)) and chum (*Oncorhynchus keta* (Walbaum in Artedi, 1792)) salmon killed by bears were carried into the forest. The tendency of bears to tranport carcasses was independent of the sex and species of salmon, but unspanwed fish were more often transported than fish that had completed spawning. Data on tagged sockeye salmon (*Oncorhynchus nerka* (Walbaum in Artedi, 1792)) in one southwestern Alaska stream indicated that 42.6% of the killed salmon were transported, and that higher percentages were transported in years when salmon densities were greater. At six other streams, on average, 68.1% of the sockeye salmon killed were apparently transported away from the stream into the forest. Combining the data from all sites, the proportion of carcasses transported increased with water depth at the site. These results emphasize the role that bears play in mediating the interactions between nutrients from salmon and the terrestrial and aquatic ecosystems, and the variation in carcass distribution among streams and among years.
101	As part of the National Park Service's Inventory and Monitoring Program, biologists from the US Geological Survey's Alaska Science Center conducted an inventory of birds in montane regions of Katmai and Lake Clark National Parks and Preserves during 2004-2006. We used a stratified random survey design to allocate samples by ecological subsection. To survey for birds, we conducted counts at 468 points across 29, 10-km x 10-km (6.2-mi x 6.2-mi) sample plots in Katmai and 417 points across 25, 10-km x 10-km sample plots in Lake Clark. We detected 92 and 104 species in Katmai and Lake Clark, respectively, including 40 species of conservation concern. We detected three species not previously recorded in Katmai (Ring-necked Duck [i], Lesser Scaup [Aythya affinis], and White-tailed Ptarmigan [Lagopus leucurus]) and two species not previously recorded in Katmai (Northern Flicker [Colaptes auratus] and Olive-sided Flycatcher [Contopus cooperi]). The most commonly detected species in both parks was Golden-crowned Sparrow (Zonotrichia atricapilla); Fox Sparrow (Passerella iliaca) and American Pipit (Anthus rubescens) were abundant and widely-distributed as well. We defined sites as low (100-350 m), middle (351-600 m), or high (601-1620 m) elevation based on the distribution of vegetation cover, and similarly categorized the 34 most-commonly detected species based on the mean elevation of sample points at which they were detected. High elevation (i.e., alpine) sites were characterized by high percent cover of dwarf shrub and bare ground habitat and supported species like Rock Ptarmigan (L. mutus), American Golden-Plover (Pluvialis dominica), Wandering Tattler (Tringa incana), Surfbird (Aphriza virgata), and Snow Bunting (Plectrophenax nivalis), all species of conservation concern. This inventory represents the first systematic survey of birds nesting in montane regions of both parks. Results from this inventory can form the foundation of subsequent monitoring efforts.

51	Alaska Peninsula/Becharof National Wildlife Refuge staff conducted a survey of spring staging waterfowl on the Naknek River in the Bristol Bay drainage, Alaska Peninsula, Alaska, from 14 March - 16 May, 2006. Standardized ground surveys have been conducted on the Naknek River since 1992 (surveys were initiated in 1991), and historical information on phenology, species composition, and abundance is presented for each survey year. In 2006, we observed 23 species, including Brant (*Branta bernicla*) for the first time since 2003. Brant and ring-necked duck (*Aythya collaris*) were only seen during disturbance surveys. We analyzed the upper and lower route data separately for first arrival date, peak count, and peak date summaries. Fifteen-year averages of these data were calculated for 13 principal species on the upper route and eight on the lower route. Peak counts were high, and arrival and peak counts were late for many waterfowl species this year. We re-sampled survey data from all years to obtain waterfowl counts with a uniform effort and then made between year comparisons. Following a standard protocol initiated in 2003, disturbance data were collected to determine disturbance rates and effects of disturbance on staging waterfowl.
66(4): 391-400	Local, short-term dispersal by the U.S. federally-threatened leopard darter, Percina pantherina, was examined in the field and in the laboratory to assess the possible effects of natural versus man-made barriers on movement. Mark-resight studies were conducted in two summers at sites in the Glover River (southeastern Oklahoma, U.S.A.). At one site, patches of 'preferred' habitat were separated by a natural riffle; at the other site, by a low-water road crossing with culverts. At the natural riffle site, darters moved downstream across the riffle, but also moved upstream into deeper water when water temperatures exceeded 29° C in the 'preferred' habitat. Use of deeper, cooler waters by this species in late summer suggests that thermal refugia may be important habitats for the long-term management of leopard darters. At the Road Crossing site, all documented movement was in a downstream direction, and at least two darters traversed culverts in the low-water bridge. Laboratory studies of movement across several types of culverts suggested that culverts significantly decrease the probability of movement among habitat patches.
157: 2169-2176	Northeastern Bristol Bay, Alaska, which includes three large estuaries, is used by multiple sea duck species during the annual cycle. Limited aerial surveys indicate that this area supports tens of thousands of king eiders and black scoters during spring migration and the autumn molt. Existing satellite telemetry data were used to assess the temporal patterns of habitat use and spatial distribution of king eiders and black scoters in northeastern Bristol Bay throughout the annual cycle. King eiders used northeastern Bristol Bay during all months of the annual cycle and black scoters used the area during spring through fall. Both species exhibited a similar seasonal pattern of use that corresponded with the timing of life cycle stages. Abundance of both species was highest during spring migration and the autumn molting period and lowest during summer. Use by king eiders did not occur during all winter months in every year of the study. King eiders were more broadly distributed than black scoters and were located farther from shore in deeper water. Core use areas had minimal overlap, suggesting a degree of spatial segregation between species and a preference for divergent habitats in northeastern Bristol Bay. Further study of potential variation in invertebrate community structure that may correlate with the observed interspecific spatial segregation in habitat use is needed to determine preferred forage and describe habitat requirements for each species. Such information is necessary to assess the potential impact that future anthropogenic or environmental changes may have on habitat quality of northeastern Bristol Bay and demography of Pacific sea duck populations that use this area.

1(1): 31-37	One of the most spectacular phenomena in nature is the annual return of millions of salmon to spawn in their natal streams and lakes along the Pacific coast of North America. The salmon die after spawning, and the nutrients and energy in their bodies, derived almost entirely from marine sources, are deposited in the freshwater ecosystems. This represents a vital input to the ecosystems used as spawning grounds. Salmon-derived nutrients make up a substantial fraction of the plants and animals in aquatic and terrestrial habitats associated with healthy salmon populations. The decline of salmon numbers throughout much of their southern range in North America has prompted concern that the elimination of this "conveyor belt" of nutrients and energy may fundamentally change the productivity of these coastal freshwater and terrestrial ecosystems, and consequently their ability to support wildlife, including salmon. If progress is to be made towards understanding and conserving the connection between migratory salmon and coastal ecosystems, scientists and decision-makers must explore and understand the vast temporal and spatial scales that characterize this relationship.
44: 1-19	Collections of stomachs from belukha whales taken by Eskimo subsistence hunters in the Bering and Chukchi Seas have greatly increased the data available on spring and summer foods in those areas. During spring migration in the Chuckchi Sea feeding seems influenced by ice conditions. Spring foods include arctic cod, shrimps and octopus. In coastal areas of the northern Bering and Chukchi Seas, summer foods include saffron cod, sculpins, herring, smelt, capelin, salmon, char, shrimps and octopus. Saffron cod was the primary prey species in Norton Sound and Eschscholtz Bay in June. Other species of fishes are eaten in relation to their seasonal patterns of distribution and abundance. Based on information from coastal residents and the literature, similar foods are used in summer from Bristol Bay to the northeastern Chukchi Sea. In Eschscholtz Bay young belukhas ate smaller saffron cod than older animals and males ate proportionately more sculpins than did females. During autumn and winter months pollock are probably the major prey in the southeastern and southcentral Bering Sea while arctic and saffron cods are probably the most important prey in more northerly areas. Prey eaten by belukhas are similar to those eaten by many species of pinnipeds and other cetaceans and harvested by commercial fisheries. Competition for food with other marine mammals and with fisheries may influence population size and productivity of belukhas.
Special Issue 14: 161-166	We studied natality in the Northern Alaska Peninsula (NAP) and Southern Alaska Peninsula (SAP) caribou (Ranger tarandus granti) herds during 1996-1999, and mortality and weights of calves during 1998 and 1999. Natality was lower in the NAP than the SAP primarily because most 3 year-old females did not produce calves in the NAP. Patterns of calf mortality in the NAP and SAP differed from those in Interior Alaska primarily because neonatal (i.e., during the first 2 weeks of life) mortality was relatively low, but mortality continued to be signficant through August in both herds, and aggregate annual mortality was extreme (86%) in the NAP. Predators probably killed more neonatal calves in the SAP, primarily because a wolf den (Canis lupus) was located on the calving area. Despite the relatively high density of brown bears (Ursus arctos) and bald eagles (Haliaeetus leucocephalus), these predators killed surprisingly few calves. Golden eagles (Aquila chrysaetos) were uncommon on the Alaska Peninsula. At least 2 calves apparently died from pneumonia in the range of the NAP but none were suspected to have died from the same disease in the range of the SAP. Heavy scavenging by bald eagles complicated determining cause of death of calves in both the NAP and SAP.

62	Cominco Alaska Exploration Corporation is investigating possible development of its large Pebble Copper porphyry deposit 20 miles northwest of the community of Iliamna in the Bristol Bay Region. Since development of the project would likely impact wildlife resources, Terra Nord was contracted to conduct a reconaissance level wildlife survey of the project area. The purposes of this report are to: 1) document the results of that survey for Cominco's ongoing assessment process; 2) summarize information on important wildlife species which would likely be impacted by project development; and 3) recommend further baseline data and information study needs where appropriate.
44	We completed a second year of aerial survey observations to monitor Black Scoter (Melanitta nigra) breeding populations in western Alaska tundra wetlands. The stratified survey design was based on analysis of intensive systematic surveys flown 1989-1997. We flew 8 survey days from 12-21 June 2004 and 11 survey days from 13-24 June 2005. For each year and observer, we estimated aerial detection rates with independent double-count observations made approximately every fourth transect. The visibility-corrected estimates of breeding populations after combining all 2004-05 data were 108,100 Black Scoter (standard error SE = 13,300), 198,900 (SE = 28,600) Greater Scaup (Aythya marila), and 42,200 (SE =13,200) Long-tailed Duck (Clangula hyemalis). Compared to the similar surveys flown 15 to 7 years ago, estimated total population size indicated declines with average annual change at -3.1% for Scoter, -5.2% for Scaup, and -3.5% for Long-tailed duck. Other factors associated with flying the survey approximately 2 weeks later in the season were confounded with, and may account for, these apparent changes in population size.
13(2): 104-110	We examined the site fidelity of spawning adult sockeye salmon (*Oncorhynchus nerka*) by tagging and releasing fish in the same stream reach (controls) and displacing them among different but nearby sites (c. 50 m away). Three sites - two above a stream junction ('upper' reach and 'pond') and one below ('lower' reach) - allowed us to compare the behavior of salmon in the presence and absence of olfactory cues and habitat similarity. Most controls of both sexes (90%) remained in the immediate vicinity of the tagging and release site. When displaced downstream, where the odors of both the upper reach and the pond were detectable, most salmon returned to their former site (65%). Displaced sockeye were more likely to return to the pond from the lower reach than from the upper one ($P = 0.05$), consistent with olfactory orientation and the hypothesis that salmon prefer certain habitats. Salmon displaced from the upper to the lower reach were much more likely to return than those displaced to the pond ($P < 0.01$), consistent with the role of odors in orientation and inconsistent with the habitat choice hypothesis.

743	The upper reaches of the Kvichak River system extend into Lake Clark National Park and Preserve. This system is the world's most productive spawning and rearing habitat for sockeye salmon. It contributes about 50 percent of sockeye salmon caught in Bristol Bay, 33 percent of the entire catch in the United States, and 16 percent of the total world catch. Wildlife abounds in and near the park and preserve. The Mulchatna caribou herd, numbering nearly 200,000 and said to be the most stable and healthiest herd in Alaska, grazes and calves along the western boundary of the park and preserve. Dall sheep and moose forage the area, and brown and black bear, wolves, lynx, foxes, and other mammals are present. Fish include five species of salmon, rainbow trout, Dolly Varen, lake trout, northern pike, and Arctic grayling. On the Cook Inlet side of the park and preserve, swans and other waterfowl nest on marshes and outwash plains and rocky cliffs in and adjacent to the park provide rookeries for puffins, cormorants, kittiwakes, and other seabirds. Seals and whales may be seen occassionally offshore. The park and preserve contains significant cultural resources since the area has been occupied since prehistoric times. Dena'ina Indians lived at Kijik on Lake Clark until the early 1900s, when they moved to Nondalton and other sites. Other prehistoric sites are located near Lake Telquana and along the upper Mulchatna River. Russian explorers, fur traders, and missionaries began traversing the region in the 1790s. The salmon industry began attracting white settlers in the early 1900s. While most of the early settlers around Lake Clark were trappers and miners, recent years have seen the development of an economy based on subsistence lifestyles, commercial fishing, and recreation activities.
79	This Conservation Plan for the Pacific Walrus in Alaska has been approved by the US Fish and Wildlife Service. During the 1988 reauthorization of the Marine Mammal Protection Act, Congress suggested conservation plans: (1) be prepared where they could benefit the population, and (2) provide certain background material and develop a strategy for achieving the primary goal of the MMPA of maintaining population stocks with their optimum sustainable population level. This plan has been developed accordingly. The Conservation Plan does not necessarily represent official positions or approval by cooperating agencies or organizations. The Conservation Plan was prepared by the staff, Marine Mammals Management, US Fish and Wildlife Service with the assistance of the Marine Mammal Commission, the Eskimo Walrus Commission, and the University of Alaska to delineate reasonable actions believed required to conserve the Pacific walrus population within the requirements of the Marine Mammal Protection Act of 1972, as amended. While many of the contributions and recommendations made by these organizations have been incorporated into this Plan, the Plan does not necessarily represent the views of these groups, nor does it always represent a consensus of these views. This Conservation Plan will be reviewed on a periodic basis on an as needed basis. The time frame for the plan is viewed as 5 years. It is subject to modification as dictated by new findings, changes in species status, completion of tasks, ongoing legal interpretation, policy changes, or Congressional direction. Completion of most tasks is dependent on obtaining additional funds.
2	None

9	None
1	None
Spec. Iss. 14: 131-142	The five naturally occurring and one transplanted caribou (*Ranger tarandus granti*) herd in southwestern Alaska composed about 20% of Alaska's caribou population in 2001. All five of the naturally occurring herds fluctuated considerably in size between the late 1800s and 2001 and for some herds the data provide and indication of long-term periodic (40-50 year) fluctuations. At the present time, the Unimak (UCH) and Southern Alaska Peninsula (SAP) are recovering from population declines, the Northern Alaska Peninusal Herd (NAP) appears to be nearing the end of a protracted decline, and the Mulchatna Herd (MCH) appears to now be declining after 20 years of rapid growth. The remaining naturally occurring herd (Kilbuck) has virtually disappeared. Nutrition had a significant effect on the size of 4-month-old and 10-month-old calves in the NAP and Nushagak Peninsula Herd (NPCH) and probably also on population growth in at least four (SAP, NAP, NPCH, and MCH) of the six caribou herds in southwestern Alaska. Predation does not appear to be sufficient to keep caribou herds in southwestern Alaska from expanding, probably because rabies is endemic in red foxes (*Vulpes vulpes*) and is periodically transferred to wolves (*Canis lupus*) and other canids. However, we found evidence that pneumonia and hoof rot may result in significant mortality of caribou in southwestern Alaska, whereas there is no evidence that disease is important in the dynamics of Interior herds. Cooperative conservation programs, such as the Kilbuck Caribou Management Plan, can be successful in restraining traditional harvest and promoting growth in caribou herds. In southwestern Alaska we also found evidence that small caribou herds can be swamped and assimilated by large herds, and fidelity to traditional calving areas can be lost.

22	This report summarizes the results of a preliminary investigation of caribou use of the proposed Pebble Copper mine site, northwest of Iliamna Lake, Alaska between April 1992 and December 1993. The Mulchatna Caribou Herd (MCH) has been expanding in range and number for the past decade and it is estimated to contain at least 82,000 animals. Seasonal ranges of the MCH include the proposed Pebble Copper mine site and associated road corridors near Iliamna Lake. Some caribou remain in the vicinity of the proposed mine throughout the year, not migrating north and west with the rest of the herd in the spring and summer. In recent years, most of the MCH shifted its winter range to concentrate on areas west from Iliamna Lake. Calving areas for the MCH are in the vicinity of the upper Mulchatna River and near the headwaters of the Koktuli River. The Koktuli River calving area is immediately adjacent to the proposed mine site. Up to 18% of the caribou harvested from the MCH are reportedly taken from areas near the proposed mine. The area offers hunters relatively good access and caribou are available throughout the hunting season.
38	This report summarizes the results of capture and survey activities on caribou radio-collared near the proposed Pebble Copper mine site, northwest of Iliamna Lake, Alaska between April 1992 and December 1993. The Mulchatna Caribou Herd (MCH) continued to expand in range and number during this investigation and was estimated to include from 110,000 to 130,000 animals. Caribou that were radio-collared near the mine site appeared to be representative of the entire MCH. Seasonal ranges included the proposed Pebble Copper mine site and associated road corridors near Iliamna Lake. In the late 1980's, most of the MCH shifted its winter range to concentrate on areas west from Iliamna Lake. Calving areas were in the vicinity of the upper Mulchatna River, Mosquito River, and Harris Creek, as well as portions of Kaskanak Creek southwest of the proposed mine. Ridges between the Nushagak and Kuskokwim drainages were favored in the summer and fall. Some caribou remained in the vicinity of the proposed mine throughout the year, not migrating north and west with the rest of the herd in the spring and summer. Large mammal observations near the mine site were also noted during this investigation. Because of the dynamic nature of the MCH and the potential for far reaching impacts of mine development, it is recommended that radio-telemetry data continue to be collected in 1994.

12: 141-152	The Alaska National Interest Lands Conservation Act (ANILCA; P.L. [Public Law] 96-487) of 1980 mandated that rural Alaskans be given priority use of fish and wildlife on federal public lands for subsistence purposes. This concept conflicts with the Alaska Constitution, which guarantees equal access to resources to all users. The resulting conflict spawned a dual state/federal management system and considerable controversy. In southwestern Alaska, this dilemma is exacerbated by the equally dominant cultures of indigenous Yup'ik Eskimos and more recent immigrants from western cultures. Although wildlife conservation is an important goal of both cultures, management philosophies and practices are dissimilar and sometimes contradictory. This is especially true for brown bears (*Ursus arctos*), which hold an important place in Yup'ik culture and are highly prized by trophy hunters. In 1991 and 1992, brown bear subsistence hunting seasons were significantly liberalized in southwest Alaska. In recognition of the potential danger of this liberalization, the state and federal regulatory boards concurrently stipulated a research program to determine bear density and harvestable surplus in a representative portion of the area. We began the investigation in 1993, but have been hampered by conflicts between Yup'ik and western beliefs. Nevertheless, we have gained important insights into dynamics of the bear population and attained a better appreciation for Yup'ik traditions. Our null hypothesis was that bear density could withstand increased harvest pressure associated with liberalized hunting seasons. We captured 60 bears and radiotracked 30 adult females for 3-4 yrs each. Our data suggest a stable population with a low reproductive rate. Although we were unable to determine population density, preliminary estimates suggest it is comparable to other areas in interior and northwestern Alaska.
127	The subsistence harvest survey in Bristol Bay has been conducted for eight years: 1995, 1997, 1999, 2000, 2001, 2002, 2004, and 2005. On the Togiak National Wildlife Refuge (Refuge), the survey has been conducted for ten years, 1995-2005. (No survey was conducted in Bristol Bay in 2003). Summary tables of Bristol Bay bird and egg harvests from 1995-2005 are included here. Summary tables of harvests for each sub-region: Togiak, Nushagak-Dillingham-Iliamna (including King Salmon-Naknek), and Alaska Peninsula, 2001-2005, are also included (Tables 1-6). Detailed harvest tables are included for each species, with estimates by survey period and sub-region, from 1995 through 2005 (Tables D-1 D44). The subsistence harvest survey in Bristol Bay includes 30 villages (Figure 1). Six of the communities are in the Togiak sub-region, 16 are in the Nushagak- Dillingham- Iliamna sub-region, and eight are in the Alaska Peninsula sub-region.
41(4): 288-292	Data on tundra swans (*Cygnus columbianus columbianus*) were obtained on the northern Alaska Peninsula from 1983 to 1987. Phenology was advanced 2-4 weeks of swan nesting areas in the Subarctic and Arctic, but a late spring retarded nesting by at least ten days. The highest densities of potential breeders (0.3-0.9 swans□km^{-2}) occurred along the lowland coast and in broad drainage basins. Estimates of the breeding population ranged from 4000 to 4600 swans. Brood sizes in August ranged from 2.7 ± 0.3 SE to 3.3 ± 0.5 young. In summer, 51-66% of the adults and subadults were observed as potential breeders, and the remainder were in nonbreeding flocks. Between 31 and 40% of the observed pairs had nests or young. The population and production on the Alaska Peninsula may be less affected by weather than populations at higher latitudes.

9(3): 489-497	Many wildlife species feed on anadromous fishes of several life-history stages. There is evidence for some wildlife species that the availability of anadromous fish is critically important for survival or reporduction. In some regions anadromous fishes in fresh water appear to be keystone food resources for vertebrate predators and scavengers, forging an ecologically significant link between aquatic and terrestrial ecosystems. The spatial distribution of anadromous fish in fresh water, including the occurrence of runs in very small streams, has important consequences for wildlife biology (social interactions, distribution, activity patterns, possibly survivorship) and conservation of biodiversity.
48(6): 455-462	(From Introduction): Anadromous and inshore-spawning marine fish provide a rich, seasonal food resource that directly affects the biology of both aquatic and terrestrial consumers and indirectly affects the entire food web that knits the water and land together. In addition, the authors suggest that the presence of a seasonally abundant food resource has helped to shape the evolution of aquatic and terrestrial consumers and that predators have proabably exerted reciprocal evolutionary pressures on their prey, potentially influencing the life history and morphology of these fishines. Finally, the authors suggest that anadromous and inshore-spawning fishes constitute such an important prey base for terrestrial wildlife that conventional ecology dogmas need to be revised. Interactions between anadromous fishes and wildlife have been recognized as having some general ecological importance (e.g., Brown 1982), but only recently have the ramifcations of these interactions and their potential magnitude begun to be explored. Because many of the ecological links still need to be described and quantified, the authors concentrate on sketching an outline of the interactions, documenting the effects where possible but also noting effects that seem probable, subject to future research.
1	Lake Iliamna, a freshwater lake located 362 km (225 mi) southwest of Anchorage, is home to a small breeding colony of harbor seals (*Phoca vitulina*). Iliamna is the largest lake in Alaska, measuring 124 km (77 mi) long and 35 km (22 mi) wide. These seals are known to live in the lake year round. Although the lake is connected to the Bristol Bay via the Kvichak River 120 km (75 mi) in length, there are no known accounts of immigration or emigration. The only other instance of a freshwater population of harbor seals is the subspecies (*P. v. mellonae*) that inhabits Lacs des Loups Marins on the Ungave Peninsula of northern Quebec, Canada. Worldwide, there are only four other lake dwelling seals (all believed to be, or descended from, ringed seals). They inhabit the freshwater Lake Baikal (*P. sibirica*); Lake Saimaa (*P. hispida saimensis*); Lake Ladoga (*P. h. ladogensis*) and the saltwater (1.2%) Caspian Sea (*P. caspica*). In a continuing effort to monitor harbor seal abundance, distribution, and trend throughout Alaska, scientists from NOAA's National Marine Mammal Laboratory (NMML) flew six surveys of Lake Iliamna in July and August 2008. These surveys occurred at different times of day and varying weather conditions to understand how covariates such as date, time of day, and weather, influence seal haul-out. The counts, unadjusted for covariates, indicated that there were at least 235 seals at the lake during the survey period. This compares with counts of 137 in 1991 (Mathisen and Kline, 1992); 321 in 1998 (Small, 2001); 225 in 1999 (Small, 2001); and 102 in 2005 (NMML, unpublished data). Iliamna seals deserve special attention. Aside from their atypical habitat, it is unknown whether these seals are genetically-isolated from other harbor seals in Bristol Bay. Potential impacts from development of the Pebble gold and copper mines, about 24 km from the lake, are of concern for these seals' conservation status and continued availability for a small subsistence harvest by Alaska Native hunters.

	None
35	None

Annotation	404(c) Categ Muncipal water supplies
The wolf management report for northern Bristol Bay (pp. 118-125) indicates wolves are common throughout the region, though historic and current abundance remains undocumented. The Nushagak and Mulchatna drainages support the highest densities in the area. Trapper reports and other observations suggest a stable population during the reporting period. Wolf population estimates are provided based on trapper questionnaires, incidental observations during moose and caribou surveys, and harvest data. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The brown bear management report for northern Bristol Bay is on pages 175 - 186. Brown bears are described as common throughout the area, and particularly abundant along salmon spawning areas in the Nushagak, Mulchatna, Togiak, and Kulukak drainages as well as throughout the Wood River/Tikchik Lakes. Hunting in the region has increased since the mid 1990s, and pressure is highest along the Nushagak River and Mulchatna River drainages and in the mountains surrounding the Wood River/Tikchik Lakes. Nonresidents account for the majority of brown bear harvest. Human activities in villages in the area frequently attract brown bears including open landfills, residential garbage, dog food, and fish-drying racks. Habitat in the region is described as virtually unaltered and in excellent condition. The report indicates proposed development of the Pebble copper and gold mine has the possibility of affecting bear habitat, though the degree of affect is unknown. Harvest data for the region are presented at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The caribou management reports for Bristol Bay (Mulchatna caribou herd) and the northern Alaska Peninsula (Northern Alaska Peninsula caribou herd) are on pages 14-42. They describe the historical abundance of both herds based on observations and aerial surveys. The Mulchatna herd probably peaked in abundance in 1996 at 200,000 animals. The 2006 estimate was 45,000 animals. Range increased and changed after herd size peaked from the north and west side of Iliamna Lake to the Kuskokwim River for wintering. Calving areas have changed as well, from the upper reaches of the Mulchatna River and the Bonanza Hills to the Mosquito River and Harris Creek drainages north of Koliganek. A possible reason for the changing range is an exceedance of carrying capacity in former wintering areas, and extensive trampling and grazing in summer areas. Population size and harvest statistics are listed for both herds. The Northern Alaska Peninsula caribou herd (NPACH) is currently in decline, of concern to ADFG. Population counts ranged from 15,000 to 19,000. The herd winters between the Naknek and Alagnak Rivers. The NPACH has been designated a population important for high levels of human consumption. Hunting has been limited in recent years due to concerns over decreasing population numbers. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	

The furbearer management report for the Bristol Bay Region is on pages 197-217. It describes trapping as an important part of the culture and economy of the residents of the region, and a primary source of income prior to the growth of the commercial fishing industry. Beaver were historically the most important furbearer in the area, but beaver trapping effort dropped as commercial salmon prices rose. Other furbearers commonly trapped in the region include red fox and land otter. Lynx, wolverines, marten, mink, and coyotes are also trapped, though less commonly. Beaver, otter, red fox, and wolverine populations are reported as stable. Lynx populations are reported as low. No data were available to assess coyote, marten, mink, or weasel population trends. Harvest statistics are presented. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The black bear management report for Bristol Bay may be found on pages 199-207 of this report. Little is known about black bears in the region, though the greatest densities are suspected to occur in the upper Mulchatna and Nushagak rivers along the Chichitnok River. Nonresidents account for the majority of reported black bear harvest. Black bear habitat in the region is described as virtually unaltered and in excellent condition. Harvest statistics are listed at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The moose management report for the Bristol Bay region may be found on pages 246-268. It describes moose as relatively new inhabitants to the region, with increasing populations during the last three decades. It indicates moose are common along the Nushagak/Mulchatna rivers and all of their major tributaries as well as the Wood-Tikchik lakes area. Population trends have been increasing dramatically in recent years despite increased predation by wolves and bears and higher harvest levels. Harvest statistics are listed at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
This document includes 40 maps outlining land designations and habitat areas in Bristol Bay for marine invertebrate gathering, waterfowl trapping, salmon, freshwater fish, marine mammals, caribou, geese, shorebirds, gulls and terns, eagles, Stellar's eiders, brown bears, and swans for each community.	

None	Yes
Pages 34-39 contain information specific to Western Alaska's shorebirds, listing priority shorebird species that commonly breed, stage during migration, or winter in the area (Table 5). The region overall hosts over 30 species of breeding shorebirds. Priority conservation issues and actions are outlined, as are threats from climate change, and shorebird hunting and collecting. This document and previous versions may be obtained from the following website: http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm.	

The article documents distribution and relative numbers of 32 species of pelagic birds observed in Bristol Bay: eight Arctic loons and three additional loons, fulmars, shearwaters, storm petrels, cormorants, ducks (including Harlequin ducks), eiders, scoters, turnstones, sandpipers, phalaropes, gulls, terns, and alcids (including marbled murrelets and puffins). Distribution maps based on transect surveys are included in the article.	
Walrus foraging marks are mapped indicating high, medium, and low use areas of Bristol Bay by walrus.	

The report concludes that brown bears extensively use the salmon streams of the area, and that the hills around the ore body are used as some of the only denning habitat along the northwest side of Iliamna Lake. Harvest data indicate that hunters use the area around the proposed mine to hunt bears. Moose surveys indicate low densities in the vicinity of the proposed mine, although harvest data indicate substantial moose hunting effort. Trapping data indicate that the area around the proposed mine is particularly popular for beaver, lynx, otter, wolf, and wolverine harvest.	
The website summarizes marine mammal research conducted by the Bristol Bay Native Association. It documents beluga whale movement in both the Nushagak and Kvichak Rivers as well as Bristol Bay on several sampling occasions in 2008 and 2009. Walrus subsistence harvest guidelines are outlined for Bristol Bay. A harvest monitoring program is described. Additional information can be found at the following website: http://www.bbna.com/website/NaturalMarine-BelWal.html#Walrus.	
None	

None	
The National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring Program report provide the most comprehensive small mammal data for the region. The area may be directly impected in the future as state mineral claims extend into the Chulitna River watershed which drains to Lake Clark. Many of the species inventoried in this report have ranges which may extend into the area.	

None	
Stellar's Eiders are listed as threatened under provisions of the US Endangered Species Act. The article indicates that Stellar's eiders occur in Alaska near headlands and in estuaries from Nunivak Island and the Yukon-Kuskokwim Delta to the southern Alaska Peninsula in the State of Alaska (including Bristol Bay).	
Maps of survey sites and tables documenting waterbird and mammal observations are appended to the report. Earlier versions of this report may be obtained from the USFWS website: http://alaska.fws.gov/mbsp/mbm/reports.htm.	
Describes the water source for Clark's Point as spring-fed wells. Water is treated with chlorine and flouride. Commercial fishing forms the economic base for the community. Fish and salmon subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes the water source for Dillingham as three deep wells. Water is treated and piped to 40% of the community. The remaining 60% use individual wells. Commercial fishing, fish processing and storage, and other support for the fishing industry forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes the water source for Ekwok as primarily individual wells. Fish and wildlife subsistence activities are crucial to the livelihood of residents as most residents are not interested in participating in a cash economy. A handful of residents fish commercially, and the village corporation owns a fishing lodge. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes the water source for Igiugig as the Kvichak River due to inadequate groundwater supplies. Should mining commence, the risk of drinking water contamination of the Kvichak River exists. Residents depend on the commercial salmon fishery as well as fish and wildlife subsistence activities. Trophy rainbow trout attract sport fishermen to the area, and seven commercial lodges operate in Igiugig, serving sport fishermen and hunters. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Iliamna as individual wells. Commercial fishing, sport fishing and tourism are listed as major sources of income for the community. Subsistence hunting and fishing is also an important source of livelihood for the community. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for King Salmon as primarily shallow individual wells, and a small community well for FAA housing. Commercial fishing is important to the King Salmon Economy, as is tourism given its proximity to Katmai National Park and Preserve. Sportfishing is also popular in the area. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Kokhanok as a piped water system as well as a separate well and treatment facility for the local school. Commercial fishing is an important, if declining economic base in the community. Most residents rely heavily on fish and wildlife subsistence. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes water source for Levelock as individual wells. Commercial fishing, fish processing, and storage form the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water source for New Stuyahok as treated community well water. The salmon fishery forms the economic base for the community. Fish and wildlife subsistence activities are crucial to the livelihood of residents. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Newhalen as treated water derived from a community well. Commercial fishing and sport fishing for trophy rainbow trout provide economic opportunities in Newhalen. Residents also depend on fish and wildlife to support their subsistence lifestyle. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Nondalton as treated surface water from Six-Mile Lake. Commercial fishing and subsistence hunting are primary sources of livelihood in the village. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Pedro Bay as individual wells or surface water from Iliamna Lake. Employment consists largely of commercial fishing and tourism services. Subsistence hunting and fishing is also an important source of livelihood. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Portage Creek as hauled from downriver (Portage Creek). Residents depend on fish and wildlife subsistence activities, and a lodge operates during the summer. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes South Naknek's water source as primarily individual wells (surface or groundwater are not indicated), and some piped water. Commercial fishing and processing are central to the economy of the village, and residents depend on subsistence hunting and fishing. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

None	
None	

The article describes the Yukon-Kuskokwim Delta and the Bristol Bay Lowlands as the two most important breeding areas for greater white-fronted geese in the Pacific Flyway. The work was stimulated by population declines of those geese. It includes a map documenting autumn migration and wintering areas.	
None	
The report includes a map of areas used by Manokotak hunters to harvest moose and marine mammals, and documents edible weight of subsistence for Manokotak and Dillingham at 2006 and 715 pounds, respectively. Mean household harvest is documented for 19 Bristol Bay communities for salmon, other fish, marine invertebrates (butter and razor clams), land mammals, marine mammals, furbearers, birds and eggs, and plants. Response to growing hunting pressure by recreational hunters is discussed.	

Similar reports for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
This report briefly describes the subsistence fisheries of the Bristol Bay Management Area, with a primary focus on the salmon fisheries. It is based on information gathered through the department's subsistence salmon permit system and from research conducted by the Division of Subsistence. The population, communities and cash economy of the region are described. General harvests in Bristol Bay are described as amongst the largest in the state and include salmon (51% of the harvest), land mammals (mostly moose and caribou, 31%), non-salmon fish (10%), and other resources such as marine mammals, birds and eggs, marine invertebrates, and wild plants (8%). The average annual value of the average household subsistence in the region is estimated at $7,195 overall, and $11,420 in village households in a region with average annual income of $13,154. Subsistence regulations are described and subsistence permit use is characterized. Results indicate subsistence salmon harvest has declined more than half in the last two decades, primarily in the Nushagak and Naknek/Kvichak districts as the result of lower average catches rather than less participation by residents. Declines are attributed to poor returns and scarcities of salmon in once reliable traditional harvest locations. The report concludes that subsistence fishing is crucial to the economy and way of life of Bristol Bay, providing nutritional and economic value, and supporting cultural and social values.	

Analysis for Port Alsworth, Nondalton, Iliamna, and Newhalen. Kvichak River sockeye salmon comprise the largest subsistence harvest in Bristol Bay, but are listed as a "stock of management concern" due to the stock's chronic inability to meet escapement goals. The study indicates that poor returns were a factor responsible for steadily declining harvest since the 1960s. Declining returns are of great concern to residents. Subsistence harvest between the four communities has ranged from about 30,000 to nearly 90,000 sockeye salmon since 1963, comprising from 44% to 89% of the total subsistence harvest. The report includes maps of subsistence fish camps and harvest locations on Iliamna Lake, Sixmile Lake, Lake Clark, and the Newhalen River. Fishing and processing is described and illustrated. Kinship relations between subsistence fishers as well as distribution of fish about the village are described using case studies. Winter fishing and non-salmon fishing are also discussed briefly. Declining populations of caribou and moose are discussed as an explanation for higher harvest goals for salmon in recent years. Increased fuel costs are a major concern in the region and also may increase subsistence harvest goals as the cost of shipping store-bought foods increases accordingly. Cultural and social values of subsistence are explored. The authors conclude subsistence fishers have developed fishing and processing practices that promote conservation and self-management, support family and community connections, as well as spirituality and cultural tradition. The subsistence fishery for these communities ultimately produces many thousands of pounds of nutritious, virtually irreplaceable food.	
In light of the crisis of salmon declines in the Pacific Northwest and the billions of dollars spent unsuccessfully to restore them, the authors review the growing body of literature examining the importance of salmon derived nutrient subsidies to both freshwater and riparian communities. The Bristol Bay region is used to illustrate the magnitude of nutrients imported from the ocean, as much as 5.4×10^7 kg of Nitrogen, 2.7×10^5 kg of Ca, plus other macroelements for a run of 20 million sockeye. Those nutrients disperse as far upstream in freshwater as suitable habitat is accessible, extending the interface between ocean and land. A multitude of species interact with and benefit from those nutrients including bears, insects, birds, benthos, zooplankton, and riparian vegetation. Salmon-derived nutrients increase lake productivity, macroinvertebrate growth, and juvenile salmon growth thereby increasing their survival. Birds associated with riparian habitat are found in greater densities on salmon streams. The carrying capacity of bears increases vastly where salmon are available. Fitness-related variables, including growth rates, litter sizes, and reproductive success, have been attributed to salmon availability for salmon consumers such as eagles, bears, and mustelids, highlighting the importance of salmon to their population dynamics. Management implications of reviewed research is discussed and the authors point out that artificially placing carcasses is not a realistic management decision due to the magnitude of carcasses that would be needed, and stream fertilization does not support the terrestrial environment like salmon. The authors indicate that the preservation of processes related to salmon-derived nutrients is of particular importance.	

None	
Wolverine harvest density is high in the Bristol Bay region relative to much of Alaska as indicated in Figure 3.	

Southwest Alaska and the Arctic-Yukon-Kuskokwim Delta are considered together for the purposes of this report, which provides a profile of sport anglers, the economic significance of sport fishing, and the net economic value to the state. It lists Bristol Bay's Naknek River as Alaska's 9th most popular sport fishing site.	

None	
Lake Iliamna seals are referred to as one of only two populations of harbor seals in the world that reside solely in freshwater without exploiting the marine environment. It indicates that they exhibit no regular movement up or down the river.	

None	
Distribution of the Mulchatna, Nushagak Peninsula, and Northern Alaska Peninsula caribou herds are illustrated in Figure 1. Population dynamics of the Mulchatna caribou herd are discussed, indicating that in 1996, the herd was the second largest in Alaska at 200,000 animals. Range changes of the herd are mapped in Figure 2. Caribou were reintroduced to the Nushagak Peninsula in 1988 and their population quickly expanded to over 1000 animals.	

Subsistence hunting for caribou, moose, bears, and sheep are described as extremely common in 18 Bristol Bay communities where surveys were conducted. 41% of households hunted moose, and 37% hunted caribou, and the vast majority of all households used moose and caribou (73.4% and 81.1%, respectively). Harvest and use of bears and Dall sheep is relatively low. Harvest of large mammals in usable pounds ranged from 16 pounds per person in Port Alsworth to 369 pounds per person in Nondalton in 2001/2002. Harvest data is presented by species and community.	
None	
This paper explores the reason the earth supports so many kinds of organisms. It focuses attention on problems of species diversity and community organization that have occupied many theoretical and empirical ecologists before and since it was written. It concludes that taxa containing many diversified species will 'evolve' more readily than undiversified taxa, with limits imposed by brain size and 'niche' space; the evolution of biological communities produces complex inter-relationships which increase the stability of the community as a whole; and that smaller organisms exhibit greater diversity than large ones, and thus the evolutionary processes are different for smaller organisms than for large ones. Hutchinson further notes in dealing with human activities, the stability provided by diversity can be valuable even to the most adaptable of all large animals.	

Describes diving behavior of Pacific walrsus in Bristol Bay including foraging for bivalve molluscs in the region.	
None	
None	

The report presents results of research estimating subsistence harvest of three wildlife species by residents of twelve communities of the northern Alaska Peninsula (Naknek, South Naknek, King Salmon, Egegik, Pilot Point, Ugashik, Port Heiden, Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) in mid-1995 through mid-1997. Data were collected by interviewing residents. Harvest estimates included 2173 caribou (mostly from the Northern Alaska Peninsula Herd), 179 moose, and 26 brown bears. Information is provided on the timing and sex of the harvests, as well as harvest locations. Comments summarizing resident interviews note a scarcity of caribou attributed by hunters to changes in migration patterns as well as competition with nonlocal hunters for caribou and moose. Most interviews indicated subsistence harvest needs were met, with a few important exceptions. Broad harvest patterns are discussed. The report concludes that large land mammal resources provide substantial quantities of food to the region's households, and additionally support fundamental cultural values of the communities examined. Similar reports for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The majority of world population of Stellar's eiders (a species listed as threatened under the US Endangered Species Act) migrates along the Bristol Bay coast of the Alaska Peninsula in the spring, and crosses the Bay. It is found in and near lagoons and shoals rich in benthic invertebrate prey. Maps of King eider flock distribution are presented in Figures 2 through 8. A list of other species observed during the surveys is included at the end of the document.	

Although the guide focuses on national parks around Bristol Bay as opposed to areas which would be directly impacted by development, it is some of the only data available regarding shellfish beds for the region. Species assemblages in Bristol Bay presumably resemble some of those described herein.	
None	

The Chignik River drains to the east coast of the Alaska Peninsula. The article documents 64 bird species in the drainage which expanded the documented range of	
None	
Results are provided for specific conductance, pH, water temperature, dissolved oxygen, alkalinity and hardness, nutrients, major ions and dissolved solids, total and dissolved trace elements, and low level mercury. Samples were collected from surface and groundwater in the immediate vicinity of the deposit, as well as the area proposed at the time for the road corridor and port facility. Groundwater is characterized around the deposit by low dissolved solids, near neutral pH, average temperature of 4°C, and high dissolved oxygen with few exceptions. Surface water quality around the deposit generally met water quality standards for aquatic-life criteria with the exception of aluminum and alkalinity. The only noted exceedance to water quality standards in groundwater along the road corridor was the pH value from the Newhalen municipal well which was over the criteria of pH 8.5 during both sampling events. Turbidity values also exceeded state water quality samples, though results were not considered reliable. Aluminum standards were exceeded in most sites sampled, and the authors state site specific aluminum criteria would be more appropriate for the area. Alkalinity standards were exceeded in nearly half of the streams sampled along the road corridor, and metals were elevated at two sites.	Yes
The report documents 9,993 caribou in 2004, ten brown bears, four moose, nine wolves, and one wolverine during transect surveys. Nine raptor species and common ravens were recorded in the study area, five of which were confirmed nesting. Twenty-five species of waterbirds were observed, with ducks as the most abundant group. Forty-six bird species were documented, 13 of which are considered conservation priority species, and ten of which were documented nesting in the study area. Along the proposed road corridor, 44 brown bears, one black bear, 14 moose, one coyote, and eight river otters were recorded. Harbor seals were documented repeatedly in Iniskin Bay of Lake Iliamna. Swans, geese, loons, gulls, shorebirds, mergansers, and ducks were observed along the proposed road corridor and in the proposed port area.	
Breeding birds documented in the area included tufted puffins, pigeon guillemots, pelagic cormorants, horned puffins, glacous-winged gulls, double-crested cormorants, and bald eagles. Researchers also recorded high densities of Harlequin ducks, which previously were proposed for listing as a threatened/endangered species. Mammals recorded consisted mainly of harbor seals. Marine habitat was also evaluated using sediment and infauna sampling.	

Describes places important to area residents and users, as well as critical habitat to key plant and animal resources identified through local ecological knowledge. The information was combined with state and federal agency data to create maps. Probable threats to the watershed are identified as commercial development, community development, recreational subdivisions, mining, roads, and global climate change. The plan outlines the following four strategic actions to address those threats: adequate flow reservations in the Nushagak River; vegetation maintenance to support fish, wildlife, and other species in the floodplain; maintenance of water quality standards for salmon and other fish; and to prevent habitat damage that could result from mining.	
The authors used satellite transmitters to document sandhill crane summer and winter movements. Seven transmitters were deployed on Bristol Bay cranes. Figures 1 and 2 present mapped results of migration activity of all cranes tagged.	
This book is a preeminent text on Pacific salmon ecology. It reviews literature from throughout the Pacific Rim, with several articles focusing on research conducted in Alaska's Bristol Bay.	

None	
The National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring Program report provides the most comprehensive data for the region. Although Lake Clark National Park and Preserve is not an area that would be directly impacted by proposed mineral development, many of the species inventoried in this report have ranges which may extend into the project area.	

None	
Highlights the risk factors to fish migration of culverts associated with road construction	
None	

None	
None	
The Northern Alaska Peninsula (NAP) caribou herd is described as important to local subsistence hunters for centuries and to guides and recreational hunters since the 1950s. Its range is described as the Alaska Peninsula from Nakenek to Port Moller (Figure 1). It reached a peak population size of 20,000 during the early 1980s, but experienced significant declines in the mid-1990s. This study was initiated to understand factors in that decline.	

The study discusses population status, hunting, management objectives and field observations for the mine area itself as well as for the project area at large for the following species: caribou, black bear, brown bear, moose, wolves, furbearers, marine mammals, swans, other waterfowl, seabirds, eagles, and specific threatened and endangered species (which the report lists only as peregrine falcons). It suggest that potential threats from the project may result not only from development itself, but also to increased access to the area that the access corridor would create.	
None	
The article indicates that sockeye salmon have the ability to detect relatively small changes in olfactory cues at a very fine scale, and a strong tendency to return to familiar sites, probably using such cues Experimentally displaced salmon returned to their natal site despite much higher likelihood of predation by bears.	

The publication outlines the history of Lake Clark National Park and Preserve, as well as surrounding areas, from the prehistoric period through the 1980s.	
The document describes Bristol Bay as important breeding habitat for Pacific walrus January through March. Their general ecology and international management are described. The report further indicates a private interest in Alaska in developing the fishery potential of clams in Bristol Bay and examines potential conflict between such an endeavor with walrus management. Authors indicate that disturbance by human activities is a major threat to walrus habitat. A conservation plan is proposed.	
Marbled murrelet is listed as a threatened species under the US Endangered Species Act. Its range is described as extending as far westward as Bristol Bay. The document details federal actions taken regarding marbled murrelet management and protection.	

The Alaska stock of Pacific walrus is profiled in this document. Its range (including Bristol Bay) is described and illustrated in Figure 1. The world population was last estimated in 2006 at 129,000 animals, the lowest population size estimated for the species. Conflicts between walrus management and commercial fisheries are described, as well as subsistence harvests in the US and Russia. The USFWS received a petition in 2008 to list the Pacific walrus under the US Endangered Species Act. That petition remains under consideration. Particular concerns to Pacific walrus are described as: oil and gas exploration, climate change, and subsistence harvest.	
Non-digital National Wetland Inventory map for the area surrounding the Pebble Deposit. The map was created utilizing 1978-1986, 1:60,000-scale, color-infrared imagery collected as part of the Alaska High Altitude Photography Acquisition Program (AHAP). The data remains to be digitized, and due date for availability of digital data is unknown. Wetlands professionals indicate the map displays extraordinarily extensive wetlands in the area. Codes to interpret the map may be obtained from: http://www.fws.gov/wetlands/_documents/gNSDI/WetlandsDeepwaterHabitatsClassification.pdf.	
None	

None	
None	

This study focuses on the Yukon-Kuskokwim Delta, but highlights potential conflicts between development and subsistence uses.	
An estimated annual average of 37,500 birds was taken for subsistence use in Bristol Bay between 2001 and 2005 (No survey was conducted in 2003). Of the total harvest, 16,100 birds (43%) were ducks, and 7,500 birds (20%) were geese. Approximately 8,200 birds (22%) were ptarmigan and 3,600 (10%) were spruce grouse. An additional 640 (2%) were swans, 574 (2%) were cranes, and 860 (2%) were other birds (Table 2). Summary tables are presented by species and year. Previous versions of this report may be obtained from the USFWS website: http://library.fws.gov/Publications.html.	
The Bristol Bay population constitutes an estimated 18% of the Pacific Flyway population, though this is one of few studies to examine their distribution, abundance, population structure, and productivity of swans in the area.	

None	
Discusses the evolving perspective on the interconnectedness between salmon and other anadromous fish species to other fish, whales, sea lions, and numerous terrestrial predators and scavengers, suggesting that the view that predators reduce fish availability for humans is both one-sided and overly limited.	
None	

The document describes fecal coliform, other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals), and petroleum sheen sampling and results in the lower Nushagak River. The objective was assess whether or not guide camps and/or villages affect bacterial counts, document present-day water quality conditions, and assess motor boat quantity/usage and petroleum sheen presence on the lower Nushagak. Fecal coliform levels exceeded drinking water quality samples at three sites. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with rare exceptions for dissolved oxygen at one site (super-saturation), pH (below 6.0), and dissolved iron at four sites (in exceedance of national secondary drinking water standards). No motorboat effects were observed. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes
The document describes fecal coliform and other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals) sampling and results in the lower Nushagak River. The objective was to build on sampling started the previous year, and to assess sampling locations for suitability for future bioassessment studies. Fecal coliform levels consistently met drinking water quality standards in 2007. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with one exception for dissolved iron at one site (in exceedance of national secondary drinking water standards). Two sites were evaluated for bioassessment suitability and diatom sampling was determined to be the best option for future sampling. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
		Yes				
		Yes	Yes			
		Yes	Yes			

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	Yes	Yes	Yes			
	Yes	Yes	Yes			

Filename	Keywords (if provided by author/s)
ADFG_2006.pdf	
ADFG_2007a.pdf	
ADFG_2007b.pdf	

ADFG_2007d.pdf	
ADFG_2008b.pdf	
ADFG_2008c.pdf	
ADFG_2010b (folder containing 41 pdfs including 40 habitat maps)	

ANDR_1990.pdf	
ASG_2008.pdf	

Bartonek_Gibson_1972.pdf	
Bornhold_et_al_2005.pdf	

Boudreau_et_al_1992.pdf	
BBNA_2010.pdf	
Cardinale_et_al_2006.pdf	

Cederholm_et_al_1999.pdf	
Cook_MacDonald_2004.pdf	Mammals, small mammals, inventory, museum specimens, Alaska, Southwest Alaska Network, Lake Clark National Park and Preserve, LACL, SWAN

Dahlheim_et_al_2000.pdf	harbor porpoise, *Phocoena phocoena*, abundance, Alaska
Dau_et_al_2000.pdf	
Dau_Mallek_2009.pdf	Aerial survey, emperor geese, waterbirds, southwest Alaska
DCRA_2010a.pdf	

DCRA_2010b.pdf	
DCRA_2010d.pdf	
DCRA_2010e.pdf	
DCRA_2010f.pdf	
DCRA_2010g.pdf	
DCRA_2010h.pdf	

DCRA_2010i.pdf	
DCRA_2010k.pdf	
DCRA_2010l.pdf	
DCRA_2010m.pdf	
DCRA_2010n.pdf	
DCRA_2010p.pdf	
DCRA_2010q.pdf	

Demory_et_al_1964.pdf	
Duffield_et_al_2007.pdf	

Ely_Takekawa_1996.pdf	
Everitt_Braham_1980.pdf	
Fall_1990.pdf	

Fall_et_al_2006a.pdf	
Fall_et_al_2006b	

Fall_et_al_2010.pdf	Kvichak District, Kvichak River, Nondalton, Iliamna, Newhalen, Port Alsworth, Sixmile Lake, Iliamna Lake, Newhalen River, Bristol Bay, Southwest Alaska, Pacific salmon, sockeye salmon, *Oncorhynchus nerka*, subsistence fishing, subsistence salmon processing methods, subsistence harvests, case study method, fish camps, traditional ecological knowledge
Gende_et_al_2002.pdf	

Gibson_Kessel_1989.pdf	Alaska, Beringia, Marbled Godwit, *Limosa fedoa beringiae*
Golden_et_al_2007.pdf	Alaska, Beringia, Marbled Godwit, *Limosa fedoa beringiae, Gulo gulo*, harvest, refugia, spatiotemporal analysis, wolverine

Haley_et_al_1999 (a folder containing the Executive Summary, all chapters, and appendices of the report)	

Hauser_2007.pdf	
Hauser_et_al_2008.pdf	freshwater harbor seal, *Phoca vitulina*, sockeye salmon, *Oncorhynchus nerka*, Iliamna Lake, scat analysis, seasonal prey, selective predation, consumption patterns

Hilderbrand_et_al_1999.pdf	bear, nitrogen, nutrient flow, salmon, spruce
Hinkes_et_al_2005.pdf	

Holen_et_al_2005.pdf	
Huston_1979.pdf	
Hutchinson_1959.pdf	

Jay_et_al_2001.pdf	time-depth-recorder, TDR, walrus, *Odobenzs rosmaras*, diving, foraging, Bristol Bay
Jay_Hills_2005.pdf	walrus, *Odobenus rosmarus*, haul-out, fidelity, Bristol Bay, foraging, seasonal distribution, transmitters
Johnson_et_al_2001.pdf	

Krieg_et_al_1998.pdf	
Larned_2007.pdf	Steller's eider, *Polysticta stelleri*, king eider, *Somateria spectabilis*, migration, population, aerial survey, waterfowl, Bering Sea, Bristol Bay

Lees_2006.pdf	Infauna, bivalve, inventory, intertidal, soft-sediment, Southwest Alaska Network, Katmai National Park and Preserve, Kenai Fjords National Park, Lake Clark National Park and Preserve
Lloyd_et_al_2008.pdf	

Narver_1970.pdf	
NDM_2005a.pdf	
NDM_2005d.pdf	
NDM_2005f.pdf	
NDM_2005i.pdf	

NMWC_2007.pdf	
Petrula_Rothe_2003.pdf	
This book is not included with the bibliography	

Quinn_et_al_2009.pdf	
Ruthrauff_et_al_2007.pdf	Alaska, birds, inventory, montane, alpine, national parks, passerines, shorebirds

Savage_Murray_2007.pdf	Alaska Peninsula, American wigeon, black scoter, Bristol Bay, cackling goose, Canada goose, common goldeneye, common merganser, disturbance, Eurasian wigeon, greater scaup, greater white-fronted goose, green-winged teal, Kvichak Bay, long-tailed duck, mallard, migration, Naknek River, northern pintail, northern shoveler, red-breasted merganser, staging, trumpeter swan, tundra swan, waterfowl
Schaefer_et_al_2003.pdf	habitat, conservation, culverts, percids, fish
Schamber_et_al_2010.pdf	

Schindler_et_al_2003.pdf	
This document is not included with the bibliography	
Sellers_et_al_2001.pdf	*Aquila chrysaetos*, bald eagle, *Canis lupus*, coyote, golden eagle, grizzly bear, *Haliaeetus leucocephalus*, pneumonia, predation, *Rangifer tarandus granti*, *Ursus arctos*, wolf

Smith_Nord_1991.pdf	
Stehn_et_al_2006.pdf	
Stewart_et_al_2004.pdf	

This document is not included with the bibliography	
USFWS_1994.pdf	
USFWS_2008.pdf	

USFWS_2010a.pdf	
USFWS_2010b.pdf	
Valkenburg_et_al_2003.pdf	*Canis latrans, Canis lupus*, coyotes, Kilbuck caribou herd, lichens, Mulchatna caribou herd, Northern Alaska Peninsula caribou herd, Nushgak caribou herd, nutrition, predation, rabies, *Rangifer tarandus granti*, Southern Alaska Peninsula caribou herd, Unimak caribou herd, volcanic ash, wolves

Van_Daele_Boudreau_1992.pdf	
Van_Daele_1994.pdf	

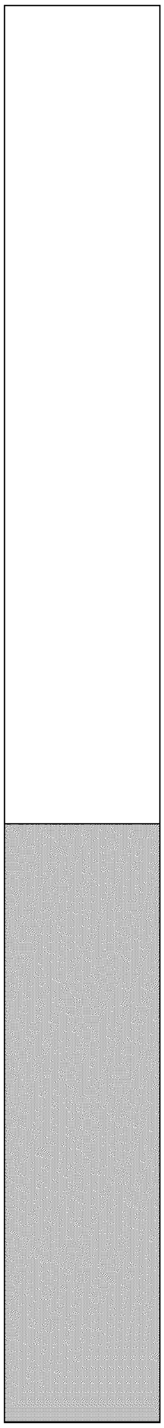
Van_Daele_et_al_2001.pdf	Alaska, Alaska National Interest Lands, Conservation Act, ANILCA, bears, brown bear, cross-cultural, Eskimo, grizzly, Kuskokwim, subsistence, *Ursus arctos*, Yup'ik
Wentworth_2007.pdf	
Wilk_1988.pdf	survey, Alaska Peninsula, Bristol Bay, Alaska, phenology, *Cygnus columbianus columbianus*, migration, productivity, tundra swan

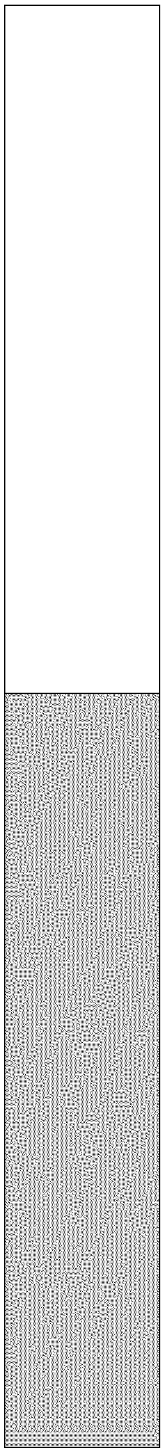
Willson_Halupka_1995.pdf	
Willson_et_al_1998.pdf	
Withrow_Yano_2008.pdf	

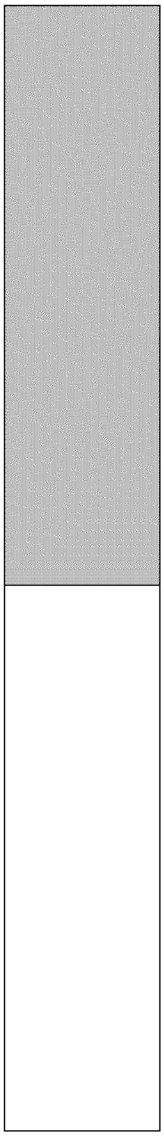
Zender_2006.pdf	
Zender_2007.pdf	

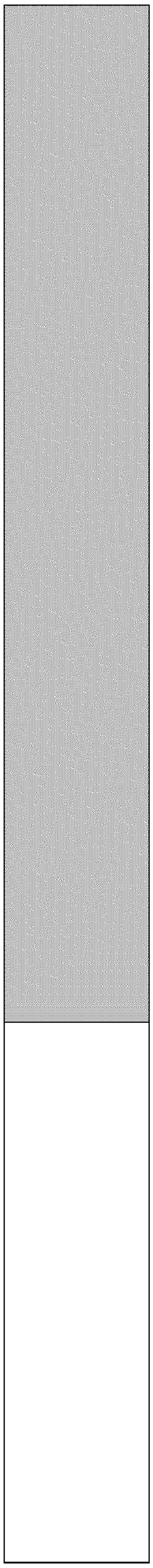
Additional notes			

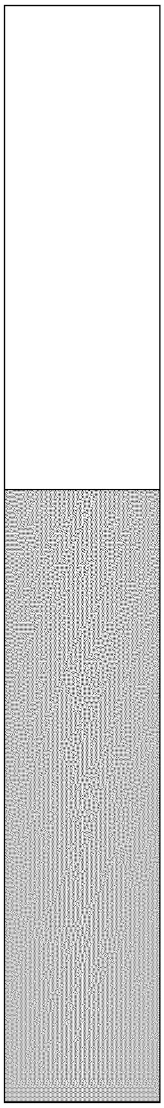
This document is a draft and indicates it should not be cited.			











Author	Year	Title	Document Type	Journal/Book Title/Publisher
ADFG	2007	Brown bear management report of survey-inventory activities 1 July 2004 - 30 June 2006	Report	ADFG, Division of Wildlife Conservation
ADFG	2007	Caribou management report of survey-inventory activities 1 July 2004-30 June 2006	Report	ADFG, Division of Wildlife Conservation
ADFG	2007	Economic impacts and contributions of sportfishing in Alaska	Government Document	ADFG, Division of Sport Fish
ADFG	2008	Anadromous Waters Atlas Naknek Index	Map	ADFG, Division of Sport Fish

ADFG	2008	Black bear management report of survey-inventory activities 1 July 2004 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation
ADFG	2008	Moose management report of survey-inventory activities 1 July 2005 - 30 June 2007	Report	ADFG, Division of Wildlife Conservation
ADFG	2009	Anadromous Water Atlas Dillingham Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Anadromous Waters Atlas Iliamna Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Anadromous Waters Atlas Lake Clark Index	Map	ADFG, Division of Sport Fish
ADFG	2009	Estimates of Southcentral Alaska sport fish harvest by species, 2000-2009	Web Page	ADFG, Division of Sport Fish
ADFG	2010	Bristol Bay critical habitat areas (Egegik, Pilot Point, Cinder River, Port Heiden, and Port Moller) management plan	Government Document	ADFG, Division of Habitat and Division of Wildlife Conservation

ADFG	2010	Southwest Alaska rainbow management policies	Government Document	ADFG
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DCRA	2010	Community Information Summaries (CIS): Ekwok	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Igiugig	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Iliamna	Web Page	Alaska Community Database

DCRA	2010	Community Information Summaries (CIS): King Salmon	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Newhalen	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Pedro Bay	Web Page	Alaska Community Database
DCRA	2010	Community Information Summaries (CIS): Port Alsworth	Web Page	Alaska Community Database

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Jennings, G.B., K. Sundet, A.E. Bingham, and D. Sigurdsson	2004	Participation, catch, and harvest in Alaska sport fisheries during 2001	Government Document	ADFG, Division of Sport Fish and Division of Commercial Fisheries

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Schwanke, C.J. and D.G. Evans	2005	Stock assessment of the rainbow trout in the Tazimina River	Government Document	ADFG, Division of Sport Fish and Division of Commercial Fisheries

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Zender Environmental Science and Planning Services	2007	Continuation of fecal coliform and water quality assessment of the Lower Nushagak River (Year 2: data collection, analysis, and report)	Report	BBNA

Pages (and Volume(issue) if applicable)	Abstract
348	None
316	
12	None
1	None

256	None
696	None
1	None
1	None
1	None
1	None
194	The Bristol Bay critical habitat areas (CHAs) are co-managed by the Alaska Department of Fish and Game (ADFG) in accordance with Alaska Statute 16.20.520-530, and the Alaska Department of Natural Resources (DNR) per AS 38.05. The purpose of the Bristol Bay Critical Habitat Areas Management Plan is to provide consistent, long-range guidance in managing the five CHAs. ADFG has undertaken this comprehensive planning process in order to establish guidelines, policies, and regulations for management of fish and wildlife, habitat, and current and future activities that affect them on the CHAs. This draft plan presents management goals for the CHAs and their resources, and identifies polices to be used in determining whether proposed activities are compatible with the protection of fish and wildlife, their habitats, and public use of the CHAs. The goals and policies of this plan are adopted as regulation. The plan does not address hunting or fishing regulations, which are the purview of the Alaska Boards of Fish and Game.

2	New regulations based on wild trout management policies now apply to popular rainbow trout waters in Southwest Alaska. These regulations were passed by the Alaska Board of Fisheries after two years of public meetings and involvement by anglers, guides, lodge owners, area residents, and the department. Management policies were adopted by the board to sustain quality wild stock rainbow populations while providing a variety of sport fishing opportunities through establishment of special areas. Also, the new board policies allow for economic development while acknowledging the value of the rainbow trout fishery to the people of Alaska.
149	This plan guides state land management by the Department of Natural Resources in the Nushagak and Mulchatna drainages and guides coastal consistency review. This plan: 1) identifies goals, management intent, and public use sites for 25 management units in the planning area; 2) specifies management policies for long-term uses (uses that take place at one site on state land for longer than 14 consecutive days), including permanent and temporary facilities, trapping cabins, boat storage, airstrip development, docks, and other uses, and specifies where these uses may be allowed and where they are prohibited; 3) includes guidelines that provide specific management direction for the 25 management units and public use sites; and 4) includes implementation information and recommendations for future management of the planning area. This plan is consistent with the goals and guidelines of the Bristol Bay Area Plan and the Bristol Bay Coastal Management Plan.
12	In December 1991, Cominco Alaska Exploration (the former lease holder of the site now held by the Pebble Limited Partnership) contracted the Alaska Department of Fish Game (ADFG), Division of Wildlife Conservation, to investigate wildlife use and harvest in the proposed Pebble Copper Mine Area, northwest of Iliamna Lake, Alaska. This paper is a compilation of information from: 1) recent moose and bear surveys conducted per the agreement between the ADFG and Cominco Exploration; 2) bear, moose, and furbearers harvest data from 1985/86 - 1990/91; 3) historic aerial survey observations documenting bear use of salmon streams; and, 4) historic trend area counts for moose. Harvest data from the proposed mine area was taken from the Uniform Coding Units (UCU) which include the drainages of Kaskanak Creek (09b-0203), Talarik Creeks (09b-0302), the Chulitna River and Nikabuna Lakes (09b-0701), and the lower Mulchatna River from the confluence with the Koktuli River to the confluence of the Nushagak River (17b-0201) (Figure 1). This report summarizes the results of the investigation. It does not speculate on the possible impacts on bear, moose, and furbearers of the proposed mine or associated facilities, nor does it offer any mitigation options for the proposed developments.

60	The US Geological Survey and the National Park Service conducted a water-quality investigation of the Kijik River Basin in Lake Clark National Park and Preserve from June 2004 to March 2005. The Kijik River Basin was studied because it has a productive sockeye salmon run that is important to the larger Kvichak River watershed. Water-quality, physical habitat, and biological characteristics were assessed. Water type throughout the Kijik River Basin is calcium bicarbonate although Little Kijik River above Kijik Lake does have slightly higher concentrations of sulfate and chloride. Alkalinity concentrations are generally less than 28 milligrams per liter, indicating a low buffering capacity of these waters. Lachbuna Lake traps much of the suspended sediment from the glacier streams in the headwaters of the basin as evidenced by low secchi-disc transparency of 1 to 2 meters and low suspended sediment concentrations in the Kijik River downstream from the lake. Kijik Lake is fed by clearwater streams and has secchi-disc readings ranging from 11 to 15 meters. Streambed sediments collected from four surface sites analyzed for trace elements indicated that arsenic concentrations at all sites were above proposed guidelines. However, arsenic concentrations are due to the local geology, not anthropogenic factors. Benthic macroinvertebrate qualitative multi-habitat samples collected from two sites on the Little Kijik River and two sites on the main stem of the Kijik River indicated a total of 69 taxa present among the four sites. The class Insecta, made up the largest percentage of macroinvertebrates, totaling 70 percent of the families found. The insects were comprised of four orders; Diptera (flies and midges), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). One-hundred twenty-two species of periphytic algae were identified in qualitative multi-habitat samples collected at the four stream sites. Eight species of non-motile, diatoms were collected from all four stream sites suggesting that the areas from which they were collected are relatively stable and unaffected by sedimentation.
145	Mean length, mean weight, percentage by age class, sample size, and standard error term statistics are presented by gear type for samples of Arctic grayling *Thymallus arcticus* collected over a 26-year period (1964 through 1989) from waters of Southwest Alaska. Of the 10,298 records summarized in tabular form, age estimates, based on scale samples, are available for approximately 7,043 records. This document is the most complete and uniform summary of available size and age information yet to be published for wild Arctic grayling stocks found in Southwest Alaska.
15	An angler effort survey was conducted on the Alagnak River from 10 June - 10 August, 2000. This was a collaborative effort between the Alaska Department of Fish and Game - Division of Sport Fish (ADFG), the National Park Service (NPS), and the Bristol Bay Native Association (BBNA). ADFG provided detailed data collection instructions and technical review of the project design. Several problems were encountered during the project and it was not completed as scheduled. However, the data collected indicated that during the study year there was heavier use of the lower river than the upper river and peak use occurred during July. Rafts were most common in the upper river and decreased in frequency with each downstream segment. Overall use was dominated by the salmon fishery in the tidal section. These data were subsequently used by ADFG to help design a more comprehensive Alagnak River Chinook and coho salmon creel survey conducted during 2001 and 2002.

34	This report details the inventory of mammals in Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003 as part of a cooperative effort of the Beringian Coevolution Project at the Museum of Southwestern Biology, University of New Mexico and the Inventory and Monitoring Program of the National Park Service of Alaska. We begin the process of documenting the approximately 36 species of mammals that occur in the Park, with a primary focus on small mammals (i.e., shrews, voles, lemmings, weasels, porcupine, squirrels, and hares). This survey resulted in 856 primary specimens comprising 17 species. Across all localities sampled, two shrews (*Sorex cinereus, S. monticolus*) and a murid rodent (*Clethrionomys rutilus*) were the most frequently captured species, comprising over 85% of all mammals sampled. The discovery of singing vole (*Microtus miurus*) at Turquoise Lake constitutes a new mammal for the park and a major range extension for the species. This inventory also provided the first documented records in LACL of pygmy shrew (Sorex hoyi), montane shrew (*Sorex monticolus*), tundra shrew (*Sorex tundrensis*), little brown bat (*Myotis lucifugus*), and ermine (*Mustela erminea*). Two tiny shrews (*Sorex yukonicus*) collected at Turner Bay are only the second record of this rare species in the park and constitutes the latest additions to the 37 specimens now known to science. The findings from this study, when combined with specimen information gathered from a review of holdings at the University of Alaska Museum and other major collections, bring the total number of documented small mammal species in LACL to 18 of 22 probable species, or 82% coverage. The specific products of this inventory include a large collection of well-prepared, well documented, and diverse preparations of mammal specimens and associated materials (tissues, parasites, fecal samples, digestive tracts) for taxonomic, zoogeographic, ecological, genetic, parasitological, epidemiological, and other research and management purposes.
3	None
3	None
3	None

3	None
3	None
3	None
2	None

35-44	This paper provides an estimate of the economic value of wild salmon ecosystems in the major watershed of Bristol Bay, Alaska. The analysis utilizes both regional economic and social benefit-cost accounting frameworks. Key sectors analyzed include subsistence, commercial fishing, sport fishing, hunting, and nonconsumptive wildlife viewing and tourism. The mixed cash-subsistence economy of Bristol Bay supports a population of 7,611 (2000 census) that is 67 percent Alaska Native. Estimated expenditures and net economic values for all sectors were based on a literature review and available data, with the exception that original data was collected for 2005 on the sport fish sector using a random sample of licensed Alaska anglers. Methods included use of a regional input-output model maintained at the University of Alaska, and survey research and contingent valuation methods for the sport fishermen. Potential respondents included 886 resident anglers and 1,514 nonresident anglers contacted through a mail/internet approach. Additionally, 300 licensed anglers, 330 clients of Bristol Bay fishing lodges, and 46 lodge owners were contacted through a mail survey. Response rates ranged from 25.6 percent for resident anglers to 44.1 percent for nonresidents. Estimated direct expenditures/sales were $234.4 million in 2005 for commercial fishing and processing, $61 million for sport fishing, $17.1 million for wildlife viewing, $7.2 million for subsistence-related expenditures, and $12.4 million for sport hunting. Nearly 100 percent of the private basic sector in Bristol Bay and 5,540 full-time equivalent jobs are supported by this $324 million estimated direct economic impact associated with wild salmon ecosystem services. Direct net economic values are estimated at $104 million to $179 million per year, and are primarily associated with the subsistence sector.
51	This report summarizes sport fisheries addressed in Bristol Bay proposals to the Alaska Board of Fisheries during 2009. Fisheries include Nushagak-Mulchatna Chinook salmon (king) *Oncorhynchus tshawytscha*, and Brooks River and American Creek rainbow trout *O. mykiss*. The sport fisheries are described, and estimates of sport effort, catch, and harvest, and escapement are provided. Overviews of management for each fishery are provided, such as pertinent sport fishing regulations and management plans, including the Nushagak-Mulchatna King Salmon Management Plan and the Southwest Alaska Rainbow Trout Management Plan.
27(2): 68-92	Since 1980, the Division of Subsistence of the Alaska Department of Fish and Game has conducted research on contemporary hunting, fishing, and gathering in Alaska Native and other rural Alaska communities. This paper describes the division's research program and some the results of the division's studies. First, there is an overview of the state and federal legislation which provides a preference for subsistence uses in resource management and allocation decisions. Next, the division's research methods are discussed, followed by a summary of some of the recent findings about the role of subsistence uses in the mixed subsistence-based economies of Alaskan villages. A description of a "baseline" study in the Central Yup'ik Eskimo village of Manokotak illustrates the kinds of information which the division has collected for about 151 communities. The paper also illustrates how these data have been applied in resource management decisions. In conclusion, the paper speculates about the future of the program in light of court decisions which may eliminate the legal protections which have pertained to subsistence uses in Alaska since 1978.

98: 189-195	Loons (Gavia spp.) were counted during the Alaska-Yukon Waterfowl Breeding Population Survey from 1971 to 1993 and the Arctic Coastal Plain Waterbird Breeding Population Survey from 1986 to 1993. Population indices for Alaska (not corrected for visibility bias) are presented by species for boreal forest, tundra, and both habitats combined. Minimum mean population estimates (1977-1993) with 95% confidence intervals were 15,360 (±2,235) Red-throated Loons (G. stellata), 69,498 (±5,596) Pacific Loons (G. pacifica), 8,886 (±843) Common Loons (G. immer) and 2,636 (±614) Yellow-billed Loons (G. adumsii). Populations of Pacific, Common and Yellow-billed Loons did not change significantly between 1977 and 1993, whereas Red-throated Loons declined by 53% to a 1993 level of 9,843 (±2,447) ($T^* = 0.65$, $P < 0.001$). Factors affecting results from aerial surveys are discussed.
450	Sport anglers reeling in salmon, halibut, and other fish generated--both directly and indirectly--an estimated three percent of jobs and payroll in Alaska in 1993. This is one of the findings of a study of the economics of sport fishing that ISER did for the Alaska Department of Fish and Game. Sport fishing is enormously popular with residents and visitors. The Department of Fish and Game estimates that nearly half a million anglers fished in Alaska in 1997, with numbers of visiting anglers slightly edging Alaskan anglers. Seven out of ten Alaska households have at least one sport angler. Nearly half of Alaska's households rate hunting and fishing opportunities as important reasons why they live where they do. The department contracted with ISER to do this study because the economics of sport fishing in Alaska is an important consideration for resource managers allocating fish stocks, evaluating fishery projects, and making decisions about land and water management. The analysis is based largely on information we collected in surveys of sport anglers and guide and charter businesses in 1993 and 1994. It's not entirely clear how sport fishing has changed since 1993. The Department of Fish and Game reports that the number of resident licenses stayed roughly the same, while the number issued to nonresidents grew about 25 percent. But at the same time, the department also reports that measures of fishing pressure-angler-days fished and numbers of fishing trips--have not changed substantially since 1993. There is some evidence that the growing number of visiting anglers may be mostly casual anglers, who fish once or twice while they're in Alaska. Numbers of sport charters operating in Southcentral and Southeast Alaska increased sharply in the 1990s, and many customers of those charters are tourists who buy single-day licenses. So the overall economic contribution of sport fishing may not have changed substantially since our survey. In any case, patterns of sport fishing--what people buy for sport fishing and how they travel to sport fishing locations, for instance--don't change quickly. We believe the broad picture of the economics of sport fishing in Alaska that we present here is valid. Below we first describe how we assessed the economics of sport fishing, then profile resident and visiting sport anglers, and conclude with our estimates of the economic value of sport fishing and its contribution to the economy.

20	The freshwater streams of the Bristol Bay drainages support important subsistence and commercial salmon fisheries and internationally-famous sport fisheries for both resident species and salmon. Northern Dynasty Mines, Inc. (NDM) has proposed to mine a metallic sulfide deposit at the headwaters of some of these streams. The project, referred to as Pebble Mine, will have a preliminary lifespan of 40 to 50 years, or even longer. Applications filed by NDM in 2006 indicate that the proposed project will leave permanent landscape features affecting some thirty square miles, including two tailings ponds that will house billions of tons of mine tailings which will include toxic materials. The project will also include a 104-mile access road, with a slurry line and a water line that will directly affect at least 12.5 square miles and a power transmission line. The 2006 applications help identify potential impacts on the fish habitat and fisheries. Categories of these potential impacts of Pebble Mine on fish habitat and fishery resources include: direct, indirect, and cumulative effects. Direct impacts will result from the approximately 30 square mile footprint of the mine, processing plant, and tailings ponds; more than 60 lineal miles of mainstem streams--plus the adjacent tributaries and wetlands--that will be totally or partially dewatered; the 12.5 square miles or 8,000 acres of disturbance from the access road; port facilities; and, power production and power supply lines. Siltation caused by road-building activities will smother fish food organisms and incubating eggs and alevins. Direct effects associated with the road also include fragmentation of aquatic, riparian, and terrestrial habitats. Indirect impacts will include increased pressure on, and competition for, fish and wildlife resources, because of the increased access to the area and increased population. Cumulative impacts will include long-term, multi-year losses of fish production and stream productivity. Over time, bridges and culverts in the access road can deteriorate and interfere with juvenile or adult fish migration between important habitats. Dust and silt from the road during the life of the project or leakage from the slurry line may smother fish food organisms and incubating fish eggs and could wash downstream to affect spawning and rearing habitat in Iliamna Lake. In addition, the weight of the roadbed and traffic can be expected to compact the soil and alter the movement of groundwater which could disrupt beach spawning by sockeye salmon in Iliamna Lake. Although the access road and other support roads will be constructed for the proposed Pebble Mine, they will also provide access to the area by other residential, commercial, and recreational users. The human population and activities can be expected to increase, and off road, all terrain vehicle use will expand into areas not previously accessible. The impact will extend much beyond the footprint of the road itself. Any real or perceived impact from the proposed Pebble Mine on Bristol Bay salmon populations will have the probability of destroying the high-
238	Since 1977, the Alaska Department of Fish and Game has conducted an annual mail survey to estimate sportfishing participation and harvests (fish kept) statewide by Alaskan fisheries, areas, regions, and species. Since 1990, catches (fish and clams harvested plus fish released) have also been estimated. Detailed findings are presented for 2001. In 2001, an estimated 432,129 anglers fished 2,261,941 days and kept 3,078,100 of the 6,775,786 fish and clams caught. The 3,216,432 fish harvested in 2002 included 788,665 razor clams *Siliqua patula* and 96,304 smelt and capelin Osmeridae. Of the remaining 2,331,463 harvested fish, 1,523,338 (65.3%) were anadromous (sea-run) salmon *Oncorhynchus*, 350,809 (15.1%) were Pacific halibut *Hippoglossus stenolepis*, 120,398 (5.2%) were rockfish Sebastes, 117,063 (5.0%) were rainbow trout *O. mykiss*, 60,994 (2.6%) were Dolly Varden *Salvelinus malma* and Arctic char *Salvelinus alpinus*, 37,910 (1.6%) were Arctic grayling *Thymallus arcticus*, and 38,498 (1.7%) were landlocked salmon (Chinook salmon, coho salmon *O. kisutch*, and kokanee *O. nerka*).

307	None
138	None
222-251	The most comprehensive "insiders" guide on Alaska fishing, revised, updated, and expanded in this new deluxe, full color 3rd edition. Written by the state's top fishing experts, this latest version now covers all 17 major Alaska sport species (fresh and salt waters), all methods (fly, spin, and bait), and all six regions of the state, with details on over 300 of the most productive Alaska fishing locations. Includes information on regional climate/conditions, run timing, visitor service costs, trophy and record fishes, USGS map references, guides' tips, fishing regulations, etc. Bonus back section with Alaska trip planner, flies for Alaska, knots, fish filleting, and a comprehensive cross-referenced index. Has over 500 color photos, maps, charts, diagrams, and drawings. Beautifully illustrated, Alaska Fishing III offers a visual feast of this scenic wonderland, with content that not only thoroughly informs, but also captures the imagination and heart of the reader.

29: 355-358	A half-century after mine closure, metal contamination from sulfide ore mining in the headwaters continues to impair riparian vegetation and aquatic macroinvertebrates along Soda Butte Creek, Yellowstone National Park. A tailings dam failure in 1950 emplaced metal-rich sediment at high flood-plain levels, above 50 yr to 100 yr flood stages in 1996 and 1997. These large natural floods removed only a small part of the contaminated sediment through bank erosion; they also failed to lower in-channel Cu concentrations, because increased erosion of mine waste during high flows balances increased inputs of uncontaminated sediments, generating no net change in concentrations. Geomorphic processes controlling movement of contaminated sediments indicate that mine impacts will persist for centuries in Soda Butte Creek and imply long-lasting impacts in similarly affected streams worldwide.
54	Methodology (IFIM) will be included in this series in the near future. The IFIM section will include a discussion of Suitability Index (SI) curves, as are used in IFIM and a discussion of SI curves available for the IFIM analysis of coho salmon habitat.
145	Data contained in this report represent the Division's most recent efforts to upgrade and update fishery statistics useful in describing Southwestern Alaska's sport fisheries. Data contained in this document were extracted from Statewide Harvest Summaries, Survey and Inventory Reports, and the Fishery Data and Manuscript Series. We consider this report to be the most comprehensive information source concerning effort and harvest statistics for the major Southwestern Alaska sport fisheries. Fisheries data in this report supersede information in previous reports and are intended for interdepartmental use only.
6	This Draft Environmental Baseline Progress Report provides a description of the work conducted for the Northern Dynasty Mines Inc. (NDM) 2004 baseline environmental program. This Pebble Project progress report presents the characterization of the existing conditions related to environmental and social conditions of the project area and their incorporation into the project design and operation. This draft report is presented for agency and stakeholder review and comment, to ensure the approach followed and results obtained provides a comprehensive and thorough baseline environmental characterization of the Pebble Project.
32	A stock assessment of rainbow trout *Oncorhynchus mykiss* was conducted during spring and fall 2004 on the Tazimina River in response to reports by user groups of decreased abundance and reduced fish size. From 22 April to 28 May 2004 a mark-recapture experiment to estimate abundance resulted in an estimate of 950 (SE = 213) rainbow trout in river of which 16% (SE = 2.3%) were sexually mature. Sampled fish ranged from 161 to 612 mm FL with a mean length of 307 mm (SE = 4.10). Between 19 and 27 August 2004 CPUE and length distribution were estimated for comparison with past research conducted during the same time frame. Four hundred fourteen (414) rainbow trout were captured with a CPUE of 3.23 rainbow trout per hour. Length distribution ranged from 82 to 518 mm with a mean of 285 mm (SE = 4.15). CPUE during 2004 was higher than previous years; however, the proportion of fish over 500 mm FL was lower.

Special Issue 14: 161-166	We studied natality in the Northern Alaska Peninsula (NAP) and Southern Alaska Peninsula (SAP) caribou (Ranger tarandus granti) herds during 1996-1999, and mortality and weights of calves during 1998 and 1999. Natality was lower in the NAP than the SAP primarily because most 3 year-old females did not produce calves in the NAP. Patterns of calf mortality in the NAP and SAP differed from those in Interior Alaska primarily because neonatal (i.e., during the first 2 weeks of life) mortality was relatively low, but mortality continued to be signficant through August in both herds, and aggregate annual mortality was extreme (86%) in the NAP. Predators probably killed more neonatal calves in the SAP, primarily because a wolf den (Canis lupus) was located on the calving area. Despite the relatively high density of brown bears (Ursus arctos) and bald eagles (Haliaeetus leucocephalus), these predators killed surprisingly few calves. Golden eagles (Aquila chrysaetos) were uncommon on the Alaska Peninsula. At least 2 calves apparently died from pneumonia in the range of the NAP but none were suspected to have died from the same disease in the range of the SAP. Heavy scavenging by bald eagles complicated determining cause of death of calves in both the NAP and SAP.
317	None
67	None

743	The upper reaches of the Kvichak River system extend into Lake Clark National Park and Preserve. This system is the world's most productive spawning and rearing habitat for sockeye salmon. It contributes about 50 percent of sockeye salmon caught in Bristol Bay, 33 percent of the entire catch in the United States, and 16 percent of the total world catch. Wildlife abounds in and near the park and preserve. The Mulchatna caribou herd, numbering nearly 200,000 and said to be the most stable and healthiest herd in Alaska, grazes and calves along the western boundary of the park and preserve. Dall sheep and moose forage the area, and brown and black bear, wolves, lynx, foxes, and other mammals are present. Fish include five species of salmon, rainbow trout, Dolly Varen, lake trout, northern pike, and Arctic grayling. On the Cook Inlet side of the park and preserve, swans and other waterfowl nest on marshes and outwash plains and rocky cliffs in and adjacent to the park provide rookeries for puffins, cormorants, kittiwakes, and other seabirds. Seals and whales may be seen occassionally offshore. The park and preserve contains significant cultural resources since the area has been occupied since prehistoric times. Dena'ina Indians lived at Kijik on Lake Clark until the early 1900s, when they moved to Nondalton and other sites. Other prehistoric sites are located near Lake Telquana and along the upper Mulchatna River. Russian explorers, fur traders, and missionaries began traversing the region in the 1790s. The salmon industry began attracting white settlers in the early 1900s. While most of the early settlers around Lake Clark were trappers and miners, recent years have seen the development of an economy based on subsistence lifestyles, commercial fishing, and recreation activities.
22	This report summarizes the results of a preliminary investigation of caribou use of the proposed Pebble Copper mine site, northwest of Iliamna Lake, Alaska between April 1992 and December 1993. The Mulchatna Caribou Herd (MCH) has been expanding in range and number for the past decade and it is estimated to contain at least 82,000 animals. Seasonal ranges of the MCH include the proposed Pebble Copper mine site and associated road corridors near Iliamna Lake. Some caribou remain in the vicinity of the proposed mine throughout the year, not migrating north and west with the rest of the herd in the spring and summer. In recent years, most of the MCH shifted its winter range to concentrate on areas west from Iliamna Lake. Calving areas for the MCH are in the vicinity of the upper Mulchatna River and near the headwaters of the Koktuli River. The Koktuli River calving area is immediately adjacent to the proposed mine site. Up to 18% of the caribou harvested from the MCH are reportedly taken from areas near the proposed mine. The area offers hunters relatively good access and caribou are available throughout the hunting season.

12: 141-152	The Alaska National Interest Lands Conservation Act (ANILCA; P.L. [Public Law] 96-487) of 1980 mandated that rural Alaskans be given priority use of fish and wildlife on federal public lands for subsistence purposes. This concept conflicts with the Alaska Constitution, which guarantees equal access to resources to all users. The resulting conflict spawned a dual state/federal management system and considerable controversy. In southwestern Alaska, this dilemma is exacerbated by the equally dominant cultures of indigenous Yup'ik Eskimos and more recent immigrants from western cultures. Although wildlife conservation is an important goal of both cultures, management philosophies and practices are dissimilar and sometimes contradictory. This is especially true for brown bears (*Ursus arctos*), which hold an important place in Yup'ik culture and are highly prized by trophy hunters. In 1991 and 1992, brown bear subsistence hunting seasons were significantly liberalized in southwest Alaska. In recognition of the potential danger of this liberalization, the state and federal regulatory boards concurrently stipulated a research program to determine bear density and harvestable surplus in a representative portion of the area. We began the investigation in 1993, but have been hampered by conflicts between Yup'ik and western beliefs. Nevertheless, we have gained important insights into dynamics of the bear population and attained a better appreciation for Yup'ik traditions. Our null hypothesis was that bear density could withstand increased harvest pressure associated with liberalized hunting seasons. We captured 60 bears and radiotracked 30 adult females for 3-4 yrs each. Our data suggest a stable population with a low reproductive rate. Although we were unable to determine population density, preliminary estimates suggest it is comparable to other areas in interior and northwestern Alaska.

64	Recent declines in the number of sockeye salmon returning to Lake Clark caused economic hardship in the region and raised resource concerns among local subsistence users and Federal managers. This final report describes findings from a two year study with two primary objectives: 1) to identify sockeye salmon spawning areas using radio telemetry, and 2) to describe genetic variation within and divergence among spawning populations. Radio Telemetry Research: A lack of information regarding spawning habitat distribution in Lake Clark instigated this study. To determine spawning distributions, 332 adult sockeye salmon were radio tagged as they entered Lake Clark in 2000 and 2001. Fish were relocated every 5-10 days by boat, plane, or remote solar powered receiver. On average, a radio tagged fish was relocated 12.7 times (range, 3 - 33) and over 3,500 relocations were made. Thirty-five spawning areas were identified, including three sites downstream of the tagging area and five sites identified by visual observation or seining. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Spawning habitat locations were mapped into the Geographic Information System for Lake Clark National Park and Preserve. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; most of which were adjacent to an obvious clear water source. About 75% of identified spawning habitats are adjacent to privately owned lands, many slated for development. Proactive measures should be taken to conserve these habitats. Genetics Research: Prior to this study genetic information was lacking for Lake Clark originating sockeye salmon populations. Molecular genetic markers provide managers with more precise tools with which to identify and manage fish populations. Small clips of fin tissue (non-lethal) were obtained from 1,442 sockeye salmon representing 13 Lake Clark and 2 northeastern Lake Iliamna spawning populations in 2000 and 2001. Allele frequencies differed significantly across 11 microsatellite loci in 94 of 105 pair-wise population comparisons. Pairwise estimates of F_{ST} ranged from 0 to 0.089. There is significant genetic divergence between populations of Lake Clark and Sixmile Lake, the latter being more similar to fish of Lake Iliamna. The reduced numbers of alleles and strong divergence of most Lake Clark populations relative to Lake Iliamna/Sixmile Lake populations suggest a bottleneck or period of low population abundance, resulting in reduced genetic diversity. The greatest bottleneck effect detected and the most genetically distinct population was found in Sucker Bay Lake. Possible causes of these bottlenecks include reductions in effective population size associated with recent poor returns or colonization of new spawning habitats. Samples shared with the Alaska Department of Fish and Game for a Bristol Bay wide analysis indicate Lake Clark originating sockeye salmon are easily

35	This report describes findings from a sockeye salmon *Oncorhynchus nerka* radio telemetry and spawning habitat study conducted in the Lake Clark watershed in 2000 and 2001. The primary objectives of this research were 1) to locate and map all major spawning aggregations 2) to determine basic characteristics of spawning habitats, and 3) to determine the distribution of private land uses and subsistence/sport use locations in relation to salmon spawning habitats. Thirty-five spawning areas were identified. Eighteen areas were newly identified. Most Lake Clark sockeye salmon spawn in the Tlikakila River, Kijik watershed and along beaches of Lake Clark and Little Lake Clark. Surprisingly, over 60% of radio tagged salmon spawned in turbid glacial waters; however, the timing of spawning activity in turbid habitats coincided with a dramatic decrease in the concentration of suspended sediment and turbidity. Water quality parameters were all within acceptable range for freshwater aquatic life. Subsistence fishing for migrating sockeye salmon occurs throughout Lake Clark near seasonal and year-round residences. Residents of Nondalton harvest red fish (spawning sockeye salmon) from spawning areas. Sport harvest occurs at the outlet of Lake Clark, the outlet of Tanalian River, and within the Kijik Lake drainage. Subsistence and sport fishers currently harvest less than one percent of the Lake Clark escapement. About 75% of identified spawning habitats are adjacent to privately owned lands, many slated for development. Proactive measures should be taken to conserve these habitats.
	None
35	None

Annotation	Muncipal water supplies
The brown bear management report for northern Bristol Bay is on pages 175 - 186. Brown bears are described as common throughout the area, and particularly abundant along salmon spawning areas in the Nushagak, Mulchatna, Togiak, and Kulukak drainages as well as throughout the Wood River/Tikchik Lakes. Hunting in the region has increased since the mid 1990s, and pressure is highest along the Nushagak River and Mulchatna River drainages and in the mountains surrounding the Wood River/Tikchik Lakes. Nonresidents account for the majority of brown bear harvest. Human activities in villages in the area frequently attract brown bears including open landfills, residential garbage, dog food, and fish-drying racks. Habitat in the region is described as virtually unaltered and in excellent condition. The report indicates proposed development of the Pebble copper and gold mine has the possibility of affecting bear habitat, though the degree of affect is unknown. Harvest data for the region are presented at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The caribou management reports for Bristol Bay (Mulchatna caribou herd) and the northern Alaska Peninsula (Northern Alaska Peninsula caribou herd) are on pages 14-42. They describe the historical abundance of both herds based on observations and aerial surveys. The Mulchatna herd probably peaked in abundance in 1996 at 200,000 animals. The 2006 estimate was 45,000 animals. Range increased and changed after herd size peaked from the north and west side of Iliamna Lake to the Kuskokwim River for wintering. Calving areas have changed as well, from the upper reaches of the Mulchatna River and the Bonanza Hills to the Mosquito River and Harris Creek drainages north of Koliganek. A possible reason for the changing range is an exceedance of carrying capacity in former wintering areas, and extensive trampling and grazing in summer areas. Population size and harvest statistics are listed for both herds. The Northern Alaska Peninsula caribou herd (NPACH) is currently in decline, of concern to ADFG. Population counts ranged from 15,000 to 19,000. The herd winters between the Naknek and Alagnak Rivers. The NPACH has been designated a population important for high levels of human consumption. Hunting has been limited in recent years due to concerns over decreasing population numbers. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The purpose of the study was to obtain current estimates of the economic contribution of sportfishing activities to the Alaska economy and develop a consistent method for producing such estimates on a regular basis. Sportfishing is important to Alaska's economy and culture. The vast majority of sportfishing takes place in the Southcentral region of Alaska, which includes Bristol Bay. $989 million were spent in 2007 in the Southcentral region, 11,535 jobs were supported by the industry, and $91 million were generated in state and local taxes. Expenditures are analyzed. About half of sportfishers are Alaska residents, and the remaining half travel from out of state.	
A map depicting water bodies in the USGS Naknek quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.	

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The black bear management report for Bristol Bay may be found on pages 199-207 of this report. Little is known about black bears in the region, though the greatest densities are suspected to occur in the upper Mulchatna and Nushagak rivers along the Chichitnok River. Nonresidents account for the majority of reported black bear harvest. Black bear habitat in the region is described as virtually unaltered and in excellent condition. Harvest statistics are listed at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The moose management report for the Bristol Bay region may be found on pages 246-268. It describes moose as relatively new inhabitants to the region, with increasing populations during the last three decades. It indicates moose are common along the Nushagak/Mulchatna rivers and all of their major tributaries as well as the Wood-Tikchik lakes area. Population trends have been increasing dramatically in recent years despite increased predation by wolves and bears and higher harvest levels. Harvest statistics are listed at the end of the report. Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
A map depicting water bodies in the USGS Dillingham quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.	
A map depicting water bodies in the USGS Iliamna quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.	
A map depicting water bodies in the USGS Lake Clark quadrangle in which anadromous fish presence has been documented (presence indicated by bold blue). Updated versions of this map may be obtained from: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/maps.maps.	
A table with sport fish harvest in southcentral Alaska (including Bristol Bay) listed by species for salmon, resident fish, as well as smelt, halibut, shark, rockfish, lingcod, Pacific cod, razor clams, and other fish. May be obtained from the ADFG website: http://www.sf.adfg.state.ak.us/Statewide/FishingSurvey/index.cfm?FA=region.results.	
This document includes 40 maps outlining land designations and habitat areas in Bristol Bay for marine invertebrate gathering, waterfowl trapping, salmon, freshwater fish, marine mammals, caribou, geese, shorebirds, gulls and terns, eagles, Stellar's eiders, brown bears, and swans for each community.	

This document describes lure restrictions for rainbow trout and lists catch-and-release and fly-fishing only areas in Southwest Alaska. It includes a map detailing fishing restrictions.	
None	Yes
The report concludes that brown bears extensively use the salmon streams of the area, and that the hills around the ore body are used as some of the only denning habitat along the northwest side of Iliamna Lake. Harvest data indicate that hunters use the area around the proposed mine to hunt bears. Moose surveys indicate low densities in the vicinity of the proposed mine, although harvest data indicate substantial moose hunting effort. Trapping data indicate that the area around the proposed mine is particularly popular for beaver, lynx, otter, wolf, and wolverine harvest.	

This report is one of very few that provide baseline habitat data in the Bristol Bay drainage area. Kijik Lake is outside of the area that would be directly impacted by mineral development, though the spawning salmon populations migrate through the project area to reach spawning beds in Kijik lake.	Yes
None	
The Alagnak River in the Kvichak drainage is generally accessed by floatplanes from King Salmon or area lodges. This report documents the number of anglers in both boats and rafts on four reaches of the river from June through August. Angling was most common in the lower river, with as many as 110 anglers per day.	

The National Park Service Southwest Alaska Network (SWAN) Inventory and Monitoring Program report provide the most comprehensive small mammal data for the region. The area may be directly impected in the future as state mineral claims extend into the Chulitna River watershed which drains to Lake Clark. Many of the species inventoried in this report have ranges which may extend into the area.	
Describes the water source for Ekwok as primarily individual wells. Fish and wildlife subsistence activities are crucial to the livelihood of residents as most residents are not interested in participating in a cash economy. A handful of residents fish commercially, and the village corporation owns a fishing lodge. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes the water source for Igiugig as the Kvichak River due to inadequate groundwater supplies. Should mining commence, the risk of drinking water contamination of the Kvichak River exists. Residents depend on the commercial salmon fishery as well as fish and wildlife subsistence activities. Trophy rainbow trout attract sport fishermen to the area, and seven commercial lodges operate in Igiugig, serving sport fishermen and hunters. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Iliamna as individual wells. Commercial fishing, sport fishing and tourism are listed as major sources of income for the community. Subsistence hunting and fishing is also an important source of livelihood for the community. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

Describes water sources for King Salmon as primarily shallow individual wells, and a small community well for FAA housing. Commercial fishing is important to the King Salmon Economy, as is tourism given its proximity to Katmai National Park and Preserve. Sportfishing is also popular in the area. Location, climate, history, culture, demographics, facilities, other utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations are also described. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Newhalen as treated water derived from a community well. Commercial fishing and sport fishing for trophy rainbow trout provide economic opportunities in Newhalen. Residents also depend on fish and wildlife to support their subsistence lifestyle. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Pedro Bay as individual wells or surface water from Iliamna Lake. Employment consists largely of commercial fishing and tourism services. Subsistence hunting and fishing is also an important source of livelihood. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes
Describes water sources for Port Alsworth as individual wells or hauled water from nearby surface water sources. The economic base of Port Alsworth relies on lodges and outfitters/guides for summer recreation, as well as limited commercial fishing. Also describes location, climate, history, culture, demographics, facilities, utilities, schools, health care, economy, transportation, organizations with local offices, and regional organizations. May be obtained from DCRA website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.	Yes

None	
Similar documents produced in previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The report includes a map of areas used by Manokotak hunters to harvest moose and marine mammals, and documents edible weight of subsistence for Manokotak and Dillingham at 2006 and 715 pounds, respectively. Mean household harvest is documented for 19 Bristol Bay communities for salmon, other fish, marine invertebrates (butter and razor clams), land mammals, marine mammals, furbearers, birds and eggs, and plants. Response to growing hunting pressure by recreational hunters is discussed.	

Population for Bristol Bay loons are as follows: 1,998 (±520) red-throated loons (*G. stellata*), 1,275 (±281) Pacific loons (*G. pacifica*), and 920 (±289) common loons (*G. immer*). Relative abundance of loons among production areas in Alaska are presented in Figure 2, and population trends from 1972 through 1992 are presented in Figure 3.	
Southwest Alaska and the Arctic-Yukon-Kuskokwim Delta are considered together for the purposes of this report, which provides a profile of sport anglers, the economic significance of sport fishing, and the net economic value to the state. It lists Bristol Bay's Naknek River as Alaska's 9th most popular sport fishing site.	

None	
Sport fishing participation is broken out by regions in tables at the end of the report. Bristol Bay is included in southcentral Alaska for the purposes of this report.	

This catalog is a numerically-ordered list of the water bodies in the Southwest Region of Alaska with documented use by anadromous fish. An associated Atlas to the Catalog of Water Important for Spawning shows cartographically the location, name and number of each water body, the anadromous fish species documented using them, and the fish life history phases for which the water bodies were documented being used by salmon. Water bodies documented receive statutory protection under sections of AS 16.05.871, which requires persons or governmental agencies to submit plans and specifications to ADFG and receive written approval in the form of a Fish Habitat Permit prior to the proposed use, construction or activities that would take place in specified water bodies. The report is updated annually based on nominations received by ADFG. Previous copies of the catalog can be obtained from ADFG: http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm/FA/main.overview.	
The report presents results of research estimating subsistence harvest of three wildlife species by residents of twelve communities of the northern Alaska Peninsula (Naknek, South Naknek, King Salmon, Egegik, Pilot Point, Ugashik, Port Heiden, Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) in mid-1995 through mid-1997. Data were collected by interviewing residents. Harvest estimates included 2173 caribou (mostly from the Northern Alaska Peninsula Herd), 179 moose, and 26 brown bears. Information is provided on the timing and sex of the harvests, as well as harvest locations. Comments summarizing resident interviews note a scarcity of caribou attributed by hunters to changes in migration patterns as well as competition with nonlocal hunters for caribou and moose. Most interviews indicated subsistence harvest needs were met, with a few important exceptions. Broad harvest patterns are discussed. The report concludes that large land mammal resources provide substantial quantities of food to the region's households, and additionally support fundamental cultural values of the communities examined. Similar reports for previous years may be obtained from the ADFG website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
The chapter discusses landscape, climate, fishing conditions, access, services, costs, as well as fishing highlights for the southwest region. It describes fishing location, access, facilities, highlights, and main species for the following southwest Alaska waterbodies: Lake Iliamna, Kvichak River, Newhalen River, Talarik Creek, Copper River (in the eastern Lake Iliamna drainage), Gibralter River, Lake Clark, Tazimina River, Naknek Lake and River, Brooks River, Alagnak River system, American Creek, Coville-Grosvenor Lakes, Lower Nushagak River, Upper Nushagak, Mulchatna River, Chilikradotna River, Koktuli River, Stuyahok River, Nuyakuk River, Wood-Tikchik Lakes, Tikchik River, Kulukak River, Togiak River system, Becharof Lake system, Ugahsik Lakes system, Ugashik Bay streams, Chignik River, Meshik River, Alaska Peninsula steelhead streams, and Dutch Harbor/Unalaska. Maps are included.	

None	
The report concludes for the first time that Bristol Bay and Alaska have an extremely valuable resource in freshwater fish stocks. It indicates that there are suitable commercial stocks of at least Arctic char (6,553 pounds harvested) and whitefish (17,328) in Iliamna Lake Freshwater fish harvest in 1964 yielded $5,645.	
The report describes recreational fishing harvest from 1977 through 1997 for southwest Alaska including the Kvichak and Nushagak Rivers, the former of which is described as the world's largest producer of sockeye salmon and the latter is described as the greatest producer of Chinook, chum, coho and pink salmon in Bristol Bay. Smelt dominate the recreational harvest, likely as a result of their abundance, while sockeye, Chinook, and coho salmon are the most frequently harvested species. Dolly Varden/char, rainbow trout, and arctic grayling are taken to a lesser extent. And lake trout, chum, salmon, Northern pike, whitefish, and burbot are harvested at relatively low levels. The value of the region's recreational fishery was estimated at $50 million for 1988. The report also discusses ongoing and complete research and management studies for the region. Management, angler effort, recreational harvest, and outlooks are documented for drainages in southwest Alaska for Chinook, coho, sockeye, rainbow trout, and other species. Similar area management reports for southwest Alaska for previous years can be found at the ADFG Sport Fish website: http://www.adfg.state.ak.us/pubs/dept_publications.php.	
None	
The study concludes that the rainbow trout population may be rebounding from depressed levels, and indicates the population is relatively protected due to catch-and-release regulations for sport fishers and the limitation of subsistence fishers to rod-and-reel fishing only. It suggests avenues for further study.	

The Northern Alaska Peninsula (NAP) caribou herd is described as important to local subsistence hunters for centuries and to guides and recreational hunters since the 1950s. Its range is described as the Alaska Peninsula from Nakenek to Port Moller (Figure 1). It reached a peak population size of 20,000 during the early 1980s, but experienced significant declines in the mid-1990s. This study was initiated to understand factors in that decline.	
This report presents the results of a detailed assessment contracted by the Alaska Department of Fish and Game to measure the economic contribution that sportfishing made to the state of Alaska and its regional economies in 2007. The most angler spending in the state occurred in the Southcentral region including Bristol Bay, at 72%. In 2007, 475,534 resident and nonresident licensed anglers fished 2.5 million days in Alaska and spent nearly $1.4 billion on licenses and stamps, trip-related expenditures, pre-purchased packages, and equipment and real estate used for fishing. The $1.4 billion of angler spending in Alaska resulted in economic activity that supported 15,879 jobs in Alaska, provided $545 million of income, and resulted in $123 million in state/local tax revenues. Nonresident angler spending in Alaska in 2007 (economic impact) was $653 million, and this supported 9,437 jobs and $67 million in state/local tax revenues. Total expenditures on guided sportfishing activities in 2007 totaled $416 million, which resulted in $641 million in total economic activity and supported 7,183 jobs. Resident anglers spent an average of $150 per day of sportfishing activity on trip-related expenses in 2007, while nonresident anglers spent an average of $448 per day in Alaska on trip-related expenses in 2007.	
This report summarizes information regarding the subsistence use of sockeye salmon and other freshwater fish gathered for a project funded by the US Fish and Wildlife Service, Fisheries Information Services. This project to document traditional ecological knowledge (TEK) was undertaken by the Nondalton Tribal Council in partnership with Lake Clark National Park and Preserve. The information is based on interviews of eighteen Nondalton residents regarding their current and past use of sockeye salmon and other freshwater fish for subsistence. It includes data regarding fishing practices, geographic locations and Dena'ina place names of traditional fishing areas; changes in relative abundance of sockeye salmon and other freshwater fish used for subsistence, and observations of change in the environment. The report does not analyze or interpret responses, but presents information in the words of residents interviewed. Results are presented for sockeye salmon, rainbow trout, Dolly Varden, whitefish, Arctic grayling, northern pike, eulochon (candlefish), suckers, and lake trout.	

The publication outlines the history of Lake Clark National Park and Preserve, as well as surrounding areas, from the prehistoric period through the 1980s.	
None	

This study focuses on the Yukon-Kuskokwim Delta, but highlights potential conflicts between development and subsistence uses.	

None	

None	
The document describes fecal coliform, other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals), and petroleum sheen sampling and results in the lower Nushagak River. The objective was assess whether or not guide camps and/or villages affect bacterial counts, document present-day water quality conditions, and assess motor boat quantity/usage and petroleum sheen presence on the lower Nushagak. Fecal coliform levels exceeded drinking water quality samples at three sites. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with rare exceptions for dissolved oxygen at one site (super-saturation), pH (below 6.0), and dissolved iron at four sites (in exceedance of national secondary drinking water standards). No motorboat effects were observed. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes
The document describes fecal coliform and other water quality parameters (standard field parameters in addition to nutrients, alkalinity, hardness, and metals) sampling and results in the lower Nushagak River. The objective was to build on sampling started the previous year, and to assess sampling locations for suitability for future bioassessment studies. Fecal coliform levels consistently met drinking water quality standards in 2007. Additional water quality parameters met almost all drinking water quality standards and chronic aquatic life criteria with one exception for dissolved iron at one site (in exceedance of national secondary drinking water standards). Two sites were evaluated for bioassessment suitability and diatom sampling was determined to be the best option for future sampling. Overall water quality was found to be excellent during the two sampling events conducted on the lower Nushagak River, and continued sampling was recommended.	Yes

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
		Yes	Yes			
		Yes	Yes			
	Yes		Yes			
	Yes		Yes			

		Yes	Yes			
		Yes	Yes			
	Yes		Yes			
	Yes		Yes			
	Yes		Yes			
Yes	Yes		Yes			
Yes	Yes	Yes	Yes			

	Yes		Yes			
	Yes	Yes	Yes			
		Yes	Yes			

	Yes		Yes			
	Yes		Yes			
	Yes		Yes			

		Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			

	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			
	Yes		Yes			

	Yes	Yes	Yes			
	Yes		Yes			
Yes	Yes	Yes	Yes			

			Yes			
	Yes	Yes	Yes			

	Yes	Yes	Yes		Yes	
Yes	Yes		Yes			

	Yes		Yes			
		Yes	Yes			
	Yes		Yes			

	Yes		Yes		Yes	
	Yes		Yes			
	Yes		Yes			
	Yes	Yes	Yes			
	Yes		Yes			

		Yes	Yes			
	Yes		Yes			
	Yes		Yes			

	Yes	Yes	Yes			
		Yes	Yes			

		Yes	Yes			

	Yes		Yes			

	Yes		Yes			
	Yes	Yes	Yes			
	Yes	Yes	Yes			

Filename	Keywords (if provided by author/s)
ADFG_2007a.pdf	
ADFG_2007b.pdf	
ADFG_2007c.pdf	
ADFG_2008a.pdf	

ADFG_2008b.pdf	
ADFG_2008c.pdf	
ADFG_2009a.pdf	
ADFG_2009b.pdf	
ADFG_2009c.pdf	
ADFG_2009d.pdf	
ADFG_2010b (folder containing 41 pdfs including 40 habitat maps)	

ADFG_2010c.pdf	
ANDR_1990.pdf	
Boudreau_et_al_1992.pdf	

Brabets_Ourso_2006.pdf	
Coggins_1992.pdf	Arctic grayling, Thymallus arcticus, Bristol Bay, age, length, weight
Collins_Dye_2005.pdf	Bristol Bay, Alaska Peninsula, Kodiak, Bristol Bay area, Naknek/Kvichak district, Alagnak River, salmon, trout, adult, harvest monitoring, angler effort index

Cook_MacDonald_2004.pdf	Mammals, small mammals, inventory, museum specimens, Alaska, Southwest Alaska Network, Lake Clark National Park and Preserve, LACL, SWAN
DCRA_2010d.pdf	
DCRA_2010e.pdf	
DCRA_2010f.pdf	

DCRA_2010g.pdf	
DCRA_2010l.pdf	
DCRA_2010n.pdf	
DCRA_2010o.pdf	

Duffield_et_al_2007.pdf	
Dye_Schwanke_2009.pdf	Bristol Bay Sport Fish Management Area, Alaska Board of Fisheries, management plan, Alagnak River, Nushagak River, Mulchatna River, Chinook Salmon, *Oncorhynchus tshawytscha*, king salmon, Kvichak River, sockeye salmon, *Oncorhynchus nerka*, rainbow trout, *Oncorhynchus mykiss*
Fall_1990.pdf	

Groves_et_al_1996.pdf	aerial surveys, Alaska breeding, distribution, *Gavia,* Gaviidae, loons, population trends, populations
Haley_et_al_1999 (a folder containing the Executive Summary, all chapters, and appendices of the report)	

Hauser_2007.pdf	
Jennings_et_al_2006.pdf	Alaska, sport, fish, fisheries, catch, harvest, angler, angler-days, survey, salmon, trout, char, Arctic grayling, northern pike, whitefish, burbot, smelt, Pacific halibut, rockfish, lingcod, razor clams, Alaska Statewide Harvest Survey, Statewide Harvest survey, SWHS

Johnson_Blanche_2010.pdf	
Krieg_et_al_1998.pdf	
This book chapter is not currently included with the bilbliography	

Marcus_et_al_2001.pdf	fluvial, flood plains, mining, sediments, Yellowstone Park, contaminants, pollution
Metsker_1967.pdf	
Minard_et_al_1998.pdf	
NDM_2005a.pdf	
Schwanke_Evans_2005.pdf	Tazimina River, rainbow trout, *Oncorhynchus mykiss*, subsistence, mark-recapture, estimation of abundance, sexual maturity composition, length composition, catch per unit effort, Arctic grayling, *Thymallus arcticus*

Sellers_et_al_2001.pdf	*Aquila chrysaetos*, bald eagle, *Canis lupus*, coyote, golden eagle, grizzly bear, *Haliaeetus leucocephalus*, pneumonia, predation, *Rangifer tarandus granti*, *Ursus arctos*, wolf
Southwick_Associates_2008.pdf	
Stickman_et_al_2003.pdf	

This document is not included with the bibliography	
Van_Daele_Boudreau_1992.pdf	

Van_Daele_et_al_2001.pdf	Alaska, Alaska National Interest Lands, Conservation Act, ANILCA, bears, brown bear, cross-cultural, Eskimo, grizzly, Kuskokwim, subsistence, *Ursus arctos*, Yup'ik

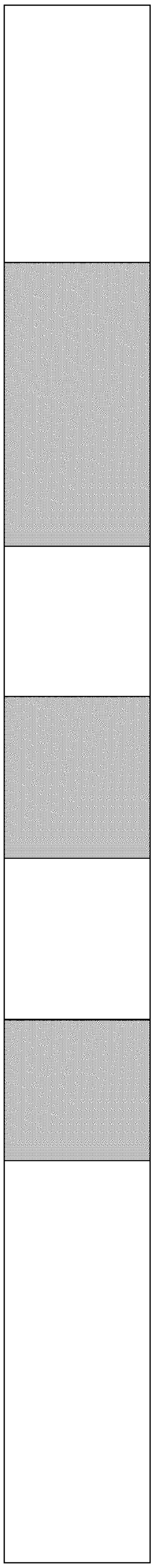
Woody_et_al_2003.pdf	Bristol Bay, genetic bottlenecks, Kvichak River, Lake Clark National Park and Preserve, microsatellites, *Oncorhynchus nerka*, radiotelemetry, sockeye salmon, salmon spawning habitat, salmon genetics, subsistence

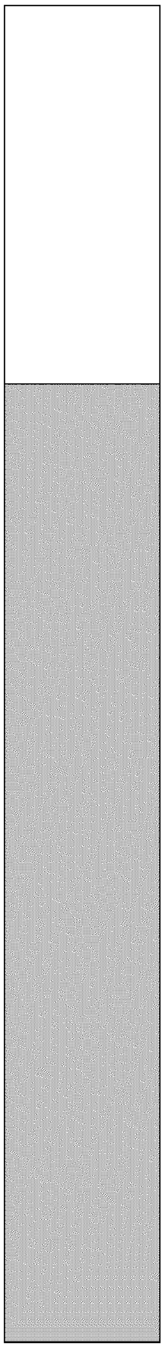
Young_2005.pdf	
Zender_2006.pdf	
Zender_2007.pdf	

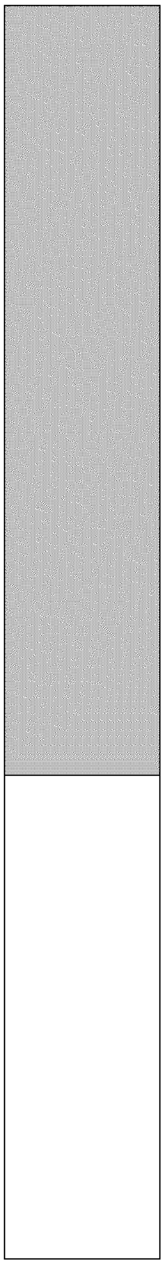
Additional notes			

This document is a draft and indicates it should not be cited.			

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]







Author	Year	Title	Document Type	Journal/Book Title/Publisher
Anderson, E.D., R.G. Eppinger, and K.D. Kelley	2009	Using regional geochemistry, geology, aeromagnetics, Landsat, and digital elevation models (DEM) to define favourable areas for porphyry-style mineralization in southwestern Alaska	Journal Article	Proceedings of the 24th IAGS, Fredericton, 2009
Chambers, D.M.	2007	Pebble engineering geology, discussion of issue	Report	Center for Science in Public Participation

Ecology and Environment Inc.	2010	An assessment of ecological risk to wild salmon systems from large-scale mining in the Nushagak and Kvichak watersheds of the Bristol Bay Basin	Report	The Nature Conservancy

Fey, D.L., M. Granitto, S.A. Giles, S.M. Smith, R.G. Eppinger, and D. Kelley	2008	Geochemical data for samples collected in 2007 near the concealed Pebble porphyry Cu-Au-Mo Deposit, southwest Alaska	Government Document	USGS
Fey, D.L., M. Granitto, S.A. Giles, S.M. Smith, R.G. Eppinger, and D. Kelley	2009	Geochemical data for samples collected in 2008 near the concealed Pebble porphyry Cu-Au-Mo Deposit, southwest Alaska	Government Document	USGS
Gaunt, J.D., C.M. Rebagliati, J. Lang, E. Titley, L. Melis, D. Barratt, and S Hodgson	2010	Technical report on the 2009 program and update on mineral resources and metallurgy, Pebble Copper-Gold-Molybdenum Project, Iliamna Lake area, southwestern Alaska, U.S.A.	Report	Northern Dynasty Minerals Ltd.

Hamilton, T.D. and R.F. Klieforth	2010	Surficial geologic map of parts of the Iliamna D-6 And D-7 Quadrangles, Pebble Project area, southwestern Alaska	Government Document	ADNR Division of Geological and Geophysical Surveys
Hawley, C.	2004	Distribution of mineral occurrences in the Iliamna 1:250,000-scale quadrangle,	Government Document	USGS

Knight Piésold Ltd.	2006	Northern Dynasty Mines Inc. Pebble Project: Tailings Impoundment A Initial application report (Ref. no. VA101-176/16-13)	Report	Knight Piésold Consulting
Knight Piésold Ltd.	2006	Northern Dynasty Mines Inc. Pebble Project: Tailings Impoundment G Initial application report (Ref. no. VA101-176/16-12)	Report	Knight Piésold Consulting

Moran, R.E.	2007	Pebble Mine: Hydrogeology and geochemistry issues	Report	Michael-Moran Associates, LLC
Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress studies: Chapter 4. Surface Water Hydrology	Report	Northern Dynasty Mines Inc.
Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress studies: Chapter 5. Groundwater Hydrogeology	Report	Northern Dynasty Mines Inc.
Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress reports: Chapter 8. Geochemical characterization and ADR/ML	Report	Northern Dynasty Mines Inc.

Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress reports: Chapter 10. Wetlands	Report	Northern Dynasty Mines Inc.
Northern Dynasty Mines Inc.	2006	Pebble Project application for water right: North Fork Koktuli River	Report	Northern Dynasty Minerals Ltd.

Northern Dynasty Mines Inc.	2006	Pebble Project application for water right: South Fork Koktuli River	Report	Northern Dynasty Mines Inc.
Northern Dynasty Mines Inc.	2006	Pebble Project application for water right: Upper Talarik Creek	Report	Northern Dynasty Mines Inc.

Pebble Limited Partnership	2010	Updated mineral resource estimate for Pebble Prospect	Report	Pebble Limited Partnership
Stratus Consulting	2010	Hydrologic analysis of the Pebble Deposit area, Alaska	Report	Stratus Consulting Inc.
USFWS	2010	National Wetlands Inventory Iliamna D-6	Map	USFWS
Zamzow, K.	2009	Impacts of exploration on water chemistry and adequancy of baseline water characterization at the Pebble Prospect 1988-2008	Report	Center for Science in Public Participation
Zamzow, K.	2010	Potential impacts to water during exploration at the Pebble Prospect, Alaska	Report	Redox Resources
Zamzow, K.	2010	Surface water quality near the proposed Pebble Mine, Alaska, 2009, Nushagak, Kvichak, and Chulitna drainage headwaters	Report	Center for Science in Public Participation

Pages (and Volume(issue) if applicable)	Abstract
345-348	The Late Cretaceous (90 Ma) Pebble Cu-Au-Mo porphyry deposit is located within the southern Kahiltna terrane, which is comprised of the Chilikadrotna Greenstone and the Koksetna River sequence. Near the Pebble deposit, the Chilikadrotna Greenstone marks the northwest border of the southern Kahiltna terrane, and the Koksetna River flysch sequence is the host for mineralization at Pebble. Throughout the world, porphyry deposits are found in clusters associated with multiple intrusive events, typically, if not always, subduction-related, thereby suggesting the southern Kahiltna terrane is potentially favourable for other porphyry occurrences. Our integration of multiple geoscientific data layers has revealed that the world-class Pebble deposit may similarly be accompanied by additional porphyry-style mineralization elsewhere in the southern Kahiltna terrane. Delineation of watersheds, derived from processing of digital elevation data, provided an effective framework for predicting favourable areas for mineralization. Beyond analysis of individual data layers of geochemistry, geology, geophysics, and remote sensing, geographic information systems (GIS) applications facilitated an integrated approach that provided a more refined and detailed process to locate potential
22	The proposed Pebble Project, by Northern Dynasty Mines, Inc. (NDM) and Anglo American plc, is a low grade copper-gold-molybdenum sulfide deposit in SW Alaska. The deposit outcrops on the surface (Pebble West, PW), requiring open pit mining methods, and extends under non-ore bearing rocks (Pebble East, PE), requiring underground block caving. The deposit sits on a drainage divide, with the Upper Talarik (UT) River draining east and south, and the North Fork (NFK) and South Fork (SFK) Koktuli rivers draining west and southwest, respectively. Mining of the ore deposit would result in an open pit and underground mine at the headwaters of the SFK and UT watersheds. The mine waste (tailings and waste rock) would be stored in two Tailings Storage Facilities located in the SFK and NFK watersheds. The PW open pit is projected to have a pit lake. Pit water can be impacted by the rock remaining in the pit walls, especially that material exposed by fracturing and rubbilization due to mining. If the water in the pit is of poor quality from decomposition of sulfide minerals, and the hydrology facilitates flow down gradient to ground and surface waters, there could be long term impacts to water off the minesite. Subsidence will likely occur due to block caving at PE. Subsidence at the surface allows water to enter the underground mine from above and contact broken rock that will remain underground. The rock in the remaining underground workings in the deposit will be mineralized. This could lead to decomposition of sulfide minerals and acid mine drainage. If a flow path exists from the mine workings to ground and surface waters down gradient from the mine, migration of contamination off the mine site would be a long term issue. Tailings dams will be built to contain waste, several with heights over 700 feet. Tailings dams must stand in perpituity. A large earthquake might cause failure of a tailings dam. A catastrophic release of a large amount of tailings could lead to long term environmental damage with huge cleanup costs. The probability of such failure is low, but the consequences are very high. A 104-mile industrial road will connect the mine and the port sites, with a concentrate pipeline parallel to the road. The pipeline will be engineered with leak detection systems and shutoff valves, though material between the shutoff valve and a break can still leak from a ruptured pipeline. Concentrates are moved via conveyor onto a ship for transport to a smelter. Concentrate spills during ship loading has been an issue in the past with similar loading facilities in Alaska. Finally, mines must be 'designed for closure.' While Alaska reclamation law requires adequate financial surety for closure be provided to the bond holding agency, regulatory agencies have a history of underestimating closure costs for metal mines. Mine closure typically costs tens to hundreds of millions of dollars, a significant liability to the regulatory agency, and by association to the taxpayer. Regulatory agencies in Alaska now accept corporate guarantees which are not backed by any tangible security

212	Ecological risk assessment (ERA) has become an essential tool for determining impacts to biological receptors as a result of contamination from metal mining facilities (Brumbaugh et al. 1994, Canfield et al. 1994, Ingersoll et al. 1994, Kemble et al. 1994, Pascoe and DalSoglio 1994, Pascoe et al. 1994, Linkov et al. 2002). The United States Environmental Protection Agency (EPA) Risk Assessment Forum developed the Framework for Metals Risk Assessment (2007a), which is a science-based document that addresses the special attributes and behaviors of metals and metal compounds to be considered when assessing their human health and ecological risks. To date, efforts have been designed to address the impacts or risks posed by metals contamination subsequent to mining operations. Few, if any, ERAs have been directed at pre-mining impacts. Smith (2007) provided strategies to predict metal mobility at mining sites through evaluation of source characterization, geoenvironmental models, geoavailability, and metals speciation; controlling physicochemical attributes (e.g., solubility, pH, sorption) in aqueous environments are discussed relative to their potential to alter metals bioavailability. The relevance of historical information on metals contamination associated with other mine sites, along with the potential for acid mine drainage (AMD) and metals release and exposure, based on review of the baseline data and geochemical characteristics at a site, have been used to develop both quantitative and qualitative predictions of risk. The present ERA is designed to analyze and portray the potential risks to globally significant salmon resources of the Nushagak-Mulchatna, and Kvichak river drainages (proximal headwater areas) as a result of large-scale mining and associated facilities. These risks include both physical destruction and alteration of salmon habitat, in addition to probable effects from changes to water chemistry and other supporting habitat as a result of AMD and the influx of metals within the aquatic ecosystem from various sources. Although the ERA generally presents impacts to salmon from loss of food resources such as benthic invertebrates, it does not focus on specific effects to these fauna. Similarly, although risks to non-anadromous fish within potentially affected stream segments may be similar to salmon, these taxa are not addressed individually within the ERA.

154	In the summer of 2007, the U.S. Geological Survey (USGS) began an exploration geochemical research study over the Pebble porphyry copper-gold-molydenum (Cu-Au-Mo) deposit in southwest Alaska. The Pebble deposit is extremely large and is almost entirely concealed by tundra, glacial deposits, and post-Cretaceous volcanic and volcaniclastic rocks. The deposit is presently being explored by Northern Dynasty Minerals, Ltd., and Anglo-American LLC. The USGS undertakes unbiased, broad-scale mineral resource assessments of government lands to provide Congress and citizens with information on national mineral endowment. Research on known deposits is also done to refine and better constrain methods and deposit models for the mineral resource assessments. The Pebble deposit was chosen for this study because it is concealed by surficial cover rocks, it is relatively undisturbed (except for exploration company drill holes), it is a large mineral system, and it is fairly well constrained at depth by the drill hole geology and geochemistry. The goals of the USGS study are (1) to determine whether the concealed deposit can be detected with surface samples, (2) to better understand the processes of metal migration from the deposit to the surface, and (3) to test and develop methods for assessing mineral resources in similar concealed terrains. This report presents analytical results for geochemical samples collected in 2007 from the Pebble deposit and surrounding environs. The analytical data are presented digitally both as an integrated Microsoft 2003 Access ® database and as Microsoft 2003 ® Excel files. The Pebble deposit is located in southwestern Alaska on state lands about 30 km (18 mi) northwest of the village of Illiamna and 320 km (200 mi) southwest of Anchorage (fig. 1). Elevations in the Pebble area range from 287 m (940 ft) at Frying Pan Lake just south of the deposit to 1146 m (3760 ft) on Kaskanak Mountain about 5 km (5 mi) to the west. The deposit is in an area of relatively subdued topographic relief with an elevation of around 300 m (1000 ft). This portion of Alaska is part of the subarctic regime mountains division, Yukon intermontane plateaus-tayga-meadow province ecoregion, as defined by Bailey (U.S. Forest Service, 2007).
120	The present report presents analytical results for geochemical samples collected in 2008 from the Pebble deposit and surrounding areas. The analytical data are presented digitally both as an integrated Microsoft 2003 Access® database and as Microsoft 2003 Excel® files. During two 2008 sampling periods, July 07-20 and September 20-24, USGS scientists collected soil, water, bedload stream sediment, bedload pond sediment, pond-sediment core, heavy-mineral concentrate, and till samples from the deposit area with the aid of helicopter support because the site currently lacks transportation infrastructure that allows ease of access. The sampling was undertaken during relatively dry and stable weather conditions. Only minor scattered rain showers occurred during the sampling periods, so surface conditions were largely unaffected by weather. The predominant sample media collected were soils, pond bedload sediments, and surface waters. This report contains the analytical results for the soil, water, stream and pond bedload sediment, and pond-sediment core samples.
195	None

23	The map area was impacted by Pleistocene-age glaciers derived from two principal sources. Glacier ice flowed southwestward down the Lake Clark structural trough, then split into separate ice tongues that penetrated the map area from the north and northeast. A second major ice body probably overflowed westward from Cook Inlet, filling Iliamna Lake basin and expanding into southern parts of the map area. At various times, these glaciers blocked each of the major drainages in the map area, creating ice-dammed lakes. These former lakes are indicated by broad expanses of unusually smooth, poorly drained, and gently sloping terrain that terminate abruptly upslope at consistent altitudes and are commonly bordered by wave- cut notches and by beach and deltaic deposits. At least four episodes of glaciation are recognized in the map area. The oldest is marked by ice-abraded uplands with thin patches of drift and by a conspicuous moraine in the southwestern corner of the map area. The younger three glacial advances correspond to the three oldest stades of the Brooks Lake glaciation, which Detterman and Reed (1973) equate with the late Wisconsin glacial substage of the North American glacial succession. This interval is dated at about 26,000 to 10,000 radiocarbon years before present (14C yr BP) elsewhere on the Alaska Peninsula (Stilwell and Kaufman, 1996) and in the upper Cook Inlet region (Reger and Pinney, 1997). During each of the two oldest stades, termed Kvichak and Iliamna by Detter- man and Reed (1973), glaciers filled the Lake Clark trough and coalesced with the much larger glacial lobe that filled the basin of Iliamna Lake. Glaciers entered the map area from both north and south at those times. During the subsequent Newhalen stade, glaciers extended only short distances southwest and south of Lake Clark; they penetrated only the extreme northeastern corner and east-central margin of the map area. Meltwater from the Newhalen glacier was deflected southwestward through eastern parts of the map area, possibly because of blockage by persisting glacier ice in Iliamna Lake basin. Broadly limiting dates elsewhere in south-central Alaska indicate that Newhalen stade glaciation may have occurred about 14,000 to 13,500 14C yr BP and that final meltout of stagnating glacier ice in the map area probably was complete by 10,000 14C yr BP.
118	None

54	The Pebble Project is a proposed copper-gold-molybdenum mine, processing facility and associated Tailings Storage Facility (TSF) located latitude 59°53’54” and longitude 155°17’44” in the Bristol Bay region of southwest Alaska, approximately 238 miles southwest of Anchorage and 17 miles northwest of the Village of Iliamna. It is situated within Iliamna D6 and D7 topographic maps in Townships 3 to 5 South, Ranges 34 to 37 West in the Seward Meridian. Northern Dynasty Mines Inc., the project owner, is developing the project, and has engaged Knight Piésold Ltd. to design the TSF, which includes the staged construction of confining dams. The procedures for applications to construct a dam are outlined in Chapter 5 of the Guidelines for Cooperation with the Alaska Dam Safety Program, dated June 2005, (the “Guidelines”) published by the Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land and Water Resources of the Alaska Department of Natural Resources. This report constitutes the Initial Application Package for submission under the Alaska Dam Safety Program as the first step towards receipt by Northern Dynasty Mines Inc. of a Certificate of Approval to Construct a Dam. The proposed impoundment will incorporate three embankment structures in the South Fork Koktuli River situated near the headwaters as follows: o A north embankment that will be progressively raised in a series of staged expansions to an ultimate height of 700 feet, o A southeast and southwest embankment that will be constructed in stages to an ultimate height of 710 feet and 740 feet, respectively. Knight Piésold Ltd. has carried out a Hazard Potential Classification of the dams, based on the classifications set out in the Guidelines. The resulting preliminary classification for each of the dams is Class II (Significant). However, Northern Dynasty Mines Inc. is planning to incorporate more stringent design criteria for flood and earthquake events consistent with a Class I (High) classification. This report provides a project description; an assessment of the site characteristics with
48	The Pebble Project is a proposed copper-gold-molybdenum mine, processing facility and associated Tailings Storage Facility (TSF) located latitude 59°53’54” and longitude 155°17’44” in the Bristol Bay region of southwest Alaska, approximately 238 miles southwest of Anchorage and 17 miles northwest of the Village of Iliamna. It is situated within Iliamna D6 and D7 topographic maps in Townships 3 to 5 South, Ranges 34 to 37 West in the Seward Meridian. Northern Dynasty Mines Inc., the project owner, is developing the project, and has engaged Knight Piésold Ltd. to design the TSF, which includes the staged construction of confining dams. The procedures for applications to construct a dam are outlined in Chapter 5 of the Guidelines for Cooperation with the Alaska Dam Safety Program, dated June 2005, (the “Guidelines”) published by the Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land and Water Resources of the Alaska Department of Natural Resources. This report constitutes the Initial Application Package for submission under the Alaska Dam Safety Program as the first step towards receipt by Northern Dynasty Mines Inc. of a Certificate of Approval to Construct a Dam. The proposed impoundment will incorporate two embankment structures in an Unnamed Tributary (NK1.190) situated near the headwaters of the North Fork Koktuli River as follows: o A main starter dam that will be progressively raised in a series of staged expansions to an ultimate height of 450 feet, o A lower saddle dam will be constructed in stages to an ultimate height of 175 feet to provide for storage capacity during the latter years of operation. Knight Piésold Ltd. has carried out a Hazard Potential Classification of the dams, based on the classifications set out in the Guidelines. The resulting preliminary classification for each of the dams is Class II (Significant). However, Northern Dynasty Mines Inc. is planning to incorporate more stringent design criteria for flood and earthquake events consistent with a Class I (High) classification.

31	This report addresses more than a dozen environmental issues arising from the hydrological and geochemical conditions at the proposed Pebble Mine, which would develop a metallic sulfide deposit in the Bristol Bay drainages of Southwest Alaska. These drainages produce a major portion of the world's sockeye salmon supply, important subsistence use, and recreation. The hydrological and geochemical issues fall into two groups. The first is "substantive" issues – e.g. (a) acid mine drainage from unprocessed waste and host rock, mine or pit walls, tailings, tailings storage facilities, and dust; (b) pollution from chemicals used in processing ore, (c) pollution from fuels, oils, greases and antifreeze; (d) pollution from residues of explosives; (e) chemical and bacteriological pollution from sewerage treatment facilities; (f) pollution from herbicides, pesticides and road deicing compounds; etc. The second group is "procedural" issues. They result from (a) inadequate data (or decisions not to release all data) particularly on matters related to hydrology and chemical compositions of rock, potential ore, waste rock, tailings, etc; (b) inadequate sampling techniques, and inadequate protocols for preserving field samples or gathering field or lab data; etc. The procedural issues weave throughout the substantive issues and undermine the ability of the public and their agencies to understand the potential, significant environmental impacts, particularly to water and fish, which will result from Pebble Mine. This report concludes that significant impacts to some of the world's most important fisheries are likely.
124	This section presents the findings of the 2004 surface-water hydrology study at the Pebble Project mine site. It summarizes data collected in 2004 as part of the baseline study program and evaluates future needs based on data gaps that are noted. Hydrologic data were also collected by Cominco, Ltd., for the Pebble Project for various periods between 1991 and 1993. These data are expected to be integrated into a future environmental baseline document, but are not included in this discussion of the 2004 data collection effort.
201	This chapter presents the findings of the hydrogeology study carried out in 2004 for the Pebble Project. The study included installation of background monitoring wells, collection of groundwater samples, and collection of additional information leading to characterization of the groundwater regime in the study area. The work was carried out by a number of firms and individuals.
51	This report presents the preliminary findings of the 2004 study of metal leaching/acid rock drainage (ML/ARD). The results presented in this report are for: • Static acid-generation testing of rock core obtained prior to 2004 (including previous drilling by Cominco Alaska), • Element scans for core collected in 2004 from the Tertiary cover rocks and periphery of the deposit near the eventual pit walls of the mine, and • Static acid-generation testing of metallurgical waste products and water-chemistry analysis from process flowsheet development. The report does not include results from leach tests and kinetic geochemical tests which are currently underway. As such, the data obtained provide an early indication of the possible geochemical nature of mine wastes but do not allow water-quality predictions to be provided.

38	Understanding the location and types of wetlands and other Waters of the United States, as defined under Section 404 of the Clean Water Act (404), is an important component of planning any development in Alaska. The regulations in 404 require an extensive analysis of development options, in order to determine the range of practicable alternatives for each project component. As such, proponents of large developments must provide mapping of areas in and around their preferred development footprint, as well as documentation to support that mapping.
170	Enclosed is an Application for Water Right submitted jointly by Northern Dynasty Mines Inc. and Northern Dynasty Holdings Inc. The mining claims that constitute the Pebble Project are held either by Northern Dynasty Holdings Inc. or its sister corporation, Northern Dynasty Mines Inc. These two Alaska corporations are submitting this application to secure rights to the supply of water needed for the beneficial mining uses in this application for the Pebble Project northwest of the community of Iliamna. Northern Dynasty Mines Inc. is and will continue to be the entity that will carry out exploration, development and administrative work relating to the Pebble Project, including ingress and egress as necessary to withdraw, impound, divert and transport water of the State of Alaska. Therefore, NDMI and NDHI are referred to, collectively, for the puroses of this application, as "Northern Dynasty Mines Inc." Each of the two entities accepts any and all responsibility and liability arising out of applying for, acquiring and holding the water right associated with this application. Submitted with the application are location maps that further identify the site where water will be taken and beneficially used, as well as the information and documentation required pursuant to 11 AAC 93.040. Also enclosed is a Coastal Project Questionnaire (CPQ). NDMI previously has submitted a CPQ for its 2006 exploration drilling program. We understand that the fee required under Alaska law for this application is to be set by negotiation. With this application, NDMI submits a check in the amount of $900 as a deposit to be applied to the fee that will be negotiated for processing this application. We are prepared to work with you to develop a fee schedule for mining projects as you determine the reasonable fee for this project, specifically. This water right application is being submitted simultaneously with two other water right applications. These three water rights are needed for a supply of water for the beneficial mining uses described in this application.

175	Enclosed is an Application for Water Right submitted jointly by Northern Dynasty Mines Inc. and Northern Dynasty Holdings Inc. The mining claims that constitute the Pebble Project are held either by Northern Dynasty Holdings Inc. or its sister corporation, Northern Dynasty Mines Inc. These two Alaska corporations are submitting this application to secure rights to the supply of water needed for the beneficial mining uses in this application for the Pebble Project northwest of the community of Iliamna. Northern Dynasty Mines Inc. is and will continue to be the entity that will carry out exploration, development and administrative work relating to the Pebble Project, including ingress and egress as necessary to withdraw, impound, divert and transport water of the State of Alaska. Therefore, NDMI and NDHI are referred to, collectively, for the puroses of this application, as "Northern Dynasty Mines Inc." Each of the two entities accepts any and all responsibility and liability arising out of applying for, acquiring and holding the water right associated with this application. Submitted with the application are location maps that further identify the site where water will be taken and beneficially used, as well as the information and documentation required pursuant to 11 AAC 93.040. Also enclosed is a Coastal Project Questionnaire (CPQ). NDMI previously has submitted a CPQ for its 2006 exploration drilling program. We understand that the fee required under Alaska law for this application is to be set by negotiation. With this application, NDMI submits a check in the amount of $900 as a deposit to be applied to the fee that will be negotiated for processing this application. We are prepared to work with you to develop a fee schedule for mining projects as you determine the reasonable fee for this project, specifically. This water right application is being submitted simultaneously with two other water right applications. These three water rights are needed for a supply of water for the beneficial mining uses described in this application.
162	Enclosed is an Application for Water Right submitted jointly by Northern Dynasty Mines Inc. and Northern Dynasty Holdings Inc. The mining claims that constitute the Pebble Project are held either by Northern Dynasty Holdings Inc. or its sister corporation, Northern Dynasty Mines Inc. These two Alaska corporations are submitting this application to secure rights to the supply of water needed for the beneficial mining uses in this application for the Pebble Project northwest of the community of Iliamna. Northern Dynasty Mines Inc. is and will continue to be the entity that will carry out exploration, development and administrative work relating to the Pebble Project, including ingress and egress as necessary to withdraw, impound, divert and transport water of the State of Alaska. Therefore, NDMI and NDHI are referred to, collectively, for the puroses of this application, as "Northern Dynasty Mines Inc." Each of the two entities accepts any and all responsibility and liability arising out of applying for, acquiring and holding the water right associated with this application. Submitted with the application are location maps that further identify the site where water will be taken and beneficially used, as well as the information and documentation required pursuant to 11 AAC 93.040. Also enclosed is a Coastal Project Questionnaire (CPQ). NDMI previously has submitted a CPQ for its 2006 exploration drilling program. We understand that the fee required under Alaska law for this application is to be set by negotiation. With this application, NDMI submits a check in the amount of $900 as a deposit to be applied to the fee that will be negotiated for processing this application. We are prepared to work with you to develop a fee schedule for mining projects as you determine the reasonable fee for this project, specifically. This water right application is being submitted simultaneously with two other water right applications. These three water rights are needed for a supply of water for the beneficial mining uses described in this application.

3	None
N/a	None
1	None
N/a	None
76	The scope of this report is limited to assessment and analysis of chemical reactions related to drilling and seismic surveys that have the potential to impact water resources. In general, contamination of surface water may occur through: fuel spills from drills and water pumps, surface discharge of drilling fluids, breakdown products of drilling chemicals, chemical reactions with drill cuttings, and ammonia from seismic charges. Contamination of groundwater may occur through: introduction of grout, clay, fuel, and drilling additives into holes and wells; improper closure of drill holes, particularly in sulfidic host rock; direct infiltration of drilling chemicals and drill cutting metals from unlined mud pits excavated within or in immediate proximity to shallow aquifers.
N/a	None

Annotation	404(c) Categ
	Muncipal water supplies
None	
None	

None	

None	
None	
The report describes property and ownership of the Pebble Copper-Gold-Molybedenum Project, as well as site geology and exploration. Exploration drilling is described in the area, and mineral resource estimates are provided as: 5.94 billion tonnes of 'Measured and Indicated Mineral Resources' grading 0.78% CuEQ, containing 55 billion pounds of copper, 67 million ounces of gold, and 3.3 billion pounds of molybdenum; and 4.84 billion tonnes of Inferred Mineral Resrouces grading 0.53% CuEQ, containing 25.6 billion pounds of copper, 40.4 million ounces of gold, and 2.3 billion pounds of molybdenum. Proposed plans for continuied exploration are provided.	

None	
Descriptions of the mineral occurrences in the Iliamna quadrangle as part of a statewide Alaska database on mines, prospects and mineral occurrences throughout Alaska.	

This application was withdrawn after its submission. It was submitted when the copper-gold-molybdenum resource was estimated at about one-fifth the size of the current estimate.	
This application was withdrawn after its submission. It was submitted when the copper-gold-molybdenum resource was estimated at about one-fifth the size of the current estimate.	

None	
None	
None	
Indicates the area surroudning the deposit possesses low buffering capacity and high potential for acid mine drainage.	

None	
None	

None	
None	

An updated report estimating the Pebble deposit mineral resources comprise: 5.94 billion tonnes of 'Measured and Indicated Mineral Resources' grading 0.78% CuEQ, containing 5 billion pounds of copper, 67 million ounces of gold and 3.3 billion pounds of molybdenum; and 4.84 billion tonnes of 'Inferred Mineral Resources' grading 0.53% CuEQ, containing 25.6 billion pounds of copper, 40.4 million ounces of gold and 2.3 billion pounds of molybdenum, based on data derived from 509 drill holes in total. At the time of this release, depsit estimates increased 17% in resources within higher confidence Measured and Indicated categories, and a 12%, 14%, and 16% increased contained in coppery, gold, and molybdenum, respectively.	
None	
Non-digital National Wetland Inventory map for the area surrounding the Pebble Deposit. The map was created utilizing 1978-1986, 1:60,000-scale, color-infrared imagery collected as part of the Alaska High Altitude Photography Acquisition Program (AHAP). The data remains to be digitized, and due date for availability of digital data is unknown. Wetlands professionals indicate the map displays extraordinarily extensive wetlands in the area. Codes to interpret the map may be obtained from: http://www.fws.gov/wetlands/_documents/gNSDI/WetlandsDeepwaterHabitatsClassification.pdf.	
None	Yes
None	
None	Yes

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
				Yes		
				Yes	Yes	

	Yes			Yes	Yes	

				Yes		
				Yes		
				Yes		

				Yes		
				Yes		

				Yes		
				Yes		

				Yes	Yes	
				Yes		
				Yes		
				Yes	Yes	

				Yes		
				Yes		

				Yes		
				Yes		

				Yes		
				Yes	Yes	
	Yes	Yes		Yes		
	Yes			Yes	Yes	
				Yes	Yes	
	Yes			Yes		

Filename	Keywords (if provided by author/s)
Anderson_et_al_2009.pdf	Pebble, Porphyry Cu-Au-Mo, Regional Targeting, Southwest Alaska, Kahiltna Terrane
Chambers_2007.pdf	

Ecology_and_Environment_Inc_2010.pdf	

Fey_et_al_2008.pdf	
Fey_et_al_2009.pdf	
Gaunt_et_al_2010.pdf	

Hamilton_Klieforth_2010.pdf	
Hawley_2004.pdf	

Knight-Piesold_2006a.pdf	
Knight-Piesold_2006b.pdf	

Moran_2007.pdf	
NDM_2005b.pdf	
NDM_2005c.pdf	
NDM_2005e.pdf	

NDM_2005g.pdf	
NDM_2006a.pdf	

NDM_2006b.pdf	
NDM_2006c.pdf	

PLP_2010.pdf	
This report is not being made available to the public because of “Do Not Cite” restriction from the Pebble Limited Partnership placed on	
USFWS_2010b.pdf	
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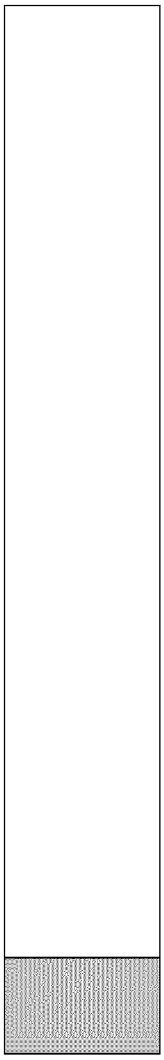
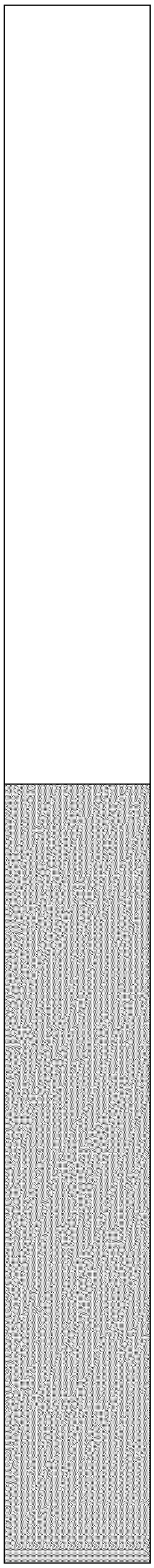
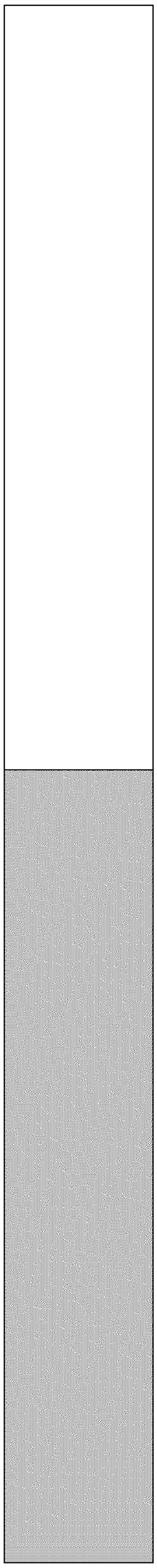
Zamzow_2010.pdf	
This report is not being made available to the public because of “Do Not Cite” restriction from the Pebble Limited Partnership placed on	

Additional notes			







Author	Year	Title	Document Type	Journal/Book Title/Publisher
Baldigo, B.P. and G.B. Lawrence	2000	Composition of fish communities in relation to stream acidification and habitat in the Neversink River, New York	Journal Article	Transactions of the American Fisheries Society
Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz	2003	Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system	Journal Article	Environmental Toxicology and Chemistry

Barry , K.L., J.A. Grout, C.D. Levings, B.H. Nidle, and G.E. Piercey	2000	Impacts of acid mine drainage on juvenile salmonids in an estuary near Britannia Beach in Howe Sound, British Columbia	Journal Article	Canadian Journal of Fisheries and Aquatic Sciences
Bash, J., C. Berman, and S. Bolton	2001	Effects of turbidity and suspended solids on salmonids	Report	Center for Streamside Studies, University of Washington

Beltman, D.J., W.H. Clements, J. Lipton, and D. Cacela	1999	Benthic invertebrate metals exposure, accumulation, and community-level effects downstream from a hard-rock mine site	Journal Article	Environmental Toxicology and Chemistry
Berg, L. and T.G. Northcote	1985	Changes in terrestrial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment	Journal Article	Canadian Journal of Fisheries and Aquatic Sciences
Bisson, P.A. and R.E. Bilby	1982	Avoidance of suspended sediment by juvenile coho salmon	Journal Article	North American Journal of Fisheries Mangement
Boillet, V., A. Bardonnet, M. Jarry, J.C. Vignes, and P. Gaudin	2005	Does embeddedness affect growth performance in juvenile salmonds? And experimental study in brown trout, *Salmo trutta* L.	Journal Article	Ecology of Freshwater Fish

Borden, R.	2001	Geochemical evolution of sulfide-bearing waste rock soils at the Bingham Canyon Mine, Utah	Journal Article	Geochemistry: Exploration, Environment, and Analysis
Chambers, D.M.	2007	Pebble engineering geology, discussion of issue	Report	Center for Science in Public Participation

Crouse, M.R., C.A. Callahan, K.W. Malueg, and S.E. Dominguez	1981	Effects of fine sediment on growth of juvenile coho salmon in laboratory streams	Journal Article	Transactions of the American Fisheries Society
Dallinger, R., F. Prosi, H. Segner, and H. Back	1987	Contaminated food and uptake of heavy metals by fish: a review and a proposal for further research	Journal Article	Oecologia
Davies, M.P.	2002	Tailings impoundment failures: Are geotechnical engineers listening?	Magazine Article	Geotechnical News
Davis Jr., R.A., A.T. Welty, J. Borrego, J.A. Morales, J.G. Pendoon, and J.G. Ryan	2000	Rio Tinto estuary (Spain): 5000 years of pollution	Journal Article	Environmental Geology

Dudka, S. and D.C. Adriano	1997	Environmental impacts of metal ore mining and processing: A review	Journal Article	Journal of Environmental Quality
Durkin, T.V. and J.G. Herrmann	1994	Focusing on the problem of mining wastes: An introduction to acid mine drainage	Government Document	No. EPA/625/R-95/007 "Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites", presented at Anaconda, MT,
Eaton, J.G. and R.M. Scheller	1996	Effects of Climate Warming on Fish Thermal Habitat in Streams of the United States	Journal Article	Limnology and Oceanography

Ecology and Environment Inc.	2010	An assessment of ecological risk to wild salmon systems from large-scale mining in the Nushagak and Kvichak watersheds of the Bristol Bay Basin	Report	The Nature Conservancy
Espana, J.S., E.L. Pamo, M. Diez, and E. Santofimia	2009	Physico-chemical gradients and meromictic stratification in Cueva de la Mora and other acidic pit lakes of the Iberian Pyrite Belt	Journal Article	Mine Water Environ

Fahrig, L. and G. Merriam	1985	Habitat Patch Connectivity and Population Survival	Journal Article	Ecology
Farag, A.M., D. Skaar, D.A. Nimick, E. MacConnell, and C. Hogstrand	2003	Characterizing the aquatic health using salmonid mortality, physiology, and biomass estimates in streams with elevated concentrations of arsenic, cadmium, copper, lead, and zinc in the Boulder River watershed, Montana	Journal Article	Transactions of the American Fisheries Society
Goldstein, J.N., D.F. Woodward, and A.M. Farag	1999	Movement of adult Chinook salmon during spawning migration in a metals-contaminated system, Coeur d'Alene River, Idaho	Journal Article	Transactions of the American Fisheries Society

Gresh, T., J. Lichatowich, and P. Schoomaker	2000	An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem	Journal Article	Fisheries
Hancock, P.J.	2002	Human impacts on the stream-groundwater exchange zone	Journal Article	Environmental Management
Hansen, J.A., J.C.A. Marr, J. Lipton, D. Cacela, and H.L. Bergman	1999	Differences in neurobehavioral responses of Chinook salmon (*Oncorhynchus tshawytscha*) and rainbow trout (*Oncorhynchus mykiss*) exposed to copper and cobalt: Behavioral avoidance	Journal Article	Environmental Toxicology and Chemistry

Hauser, W.J.	2007	Potential impacts of the proposed Pebble Mine on fish habitat and fishery resources of Bristol Bay	Report	Fish Talk, Consulting

Heikkinen, P.M., M.L. Raisanen, and R.H. Johnson	2009	Geochemical characterisation of seepage and drainage water quality from two sulphide mine tailings impoundments: Acid mine drainage versus neutral mine drainage	Journal Article	Mine Water and Environment

Hudson-Edwards, K.A., M.G. Macklin, H.E. Jamieson, P.A. Brewer, T.J. Coulthard, A.J. Howard, and J.N. Turner	2003	The impact of tailings dam spills and clean-up operations on sediment and water quality in river systems: the Rios Agrio-Guadiamar, Aznalcóllar, Spain	Journal Article	Applied Geochemistry

Jackson, S.D.	2003	Ecological considerations in the design of river and stream crossings	Book Section	Proceedings of the International Conference on Ecology and Transportation
Kaeser, A.J. and W.E. Sharpe	2001	The influence of acidic runoff episodes on slimy sculpin reproduction in Stone Run	Journal Article	Transactions of the American Fisheries Society

Kemp, P.S., M.H. Gessel, B.P. Sandford and J.G. Williams	2006	The behaviour of Pacific salmonid smolts during passage over two experimental weirs under light and dark conditions	Journal Article	River Research and Applications
Kuipers, J.R., A.S. Maest, K.A. MacHardy, and G. Lawson	2006	Comparison of predicted and actual water quality at hardrock mines: the reliability of predictions in environmental impact statements	Report	Kuipers and Associates, Buka Environmental, and Earthworks
Lauren, D.J. and D.G. McDonald	1986	Influence of water hardness, pH, and alkalinity on the mechanisms of copper toxicity in juvenile rainbow trout (*Salmo gairdneri*)	Journal Article	Canadian Journal of Fisheries and Aquatic Sciences

Malmqvist, B. and P.O. Hoffsten	1999	Influence of drainage from old mine deposits on benthic macroinvertebrate communities in central Swedish streams	Journal Article	Water Research
Marcus, W.A., G.A. Meyer, and D.R. Nimmo	2001	Geomorphic control of persistent mine impacts in a Yellowstone Park stream and implications for the recovery of fluvial systems	Journal Article	Geology
Moran, R.E.	2007	Pebble Mine: Hydrogeology and geochemistry issues	Report	Michael-Moran Associates, LLC

Nelson, R.L., M.L. McHenry, and W.S. Platts	1991	Mining	Book Section	Influences of forest and rangeland management on salmonid fishes and their habitats (American Fisheries Society Special Publication no. 19)
Nordstrom, D.K. and C.N. Alpers	1999	Negative pH, efflorescent mineralogy, and consequences for environmental restoration at the Iron Mountain Superfund site, California	Journal Article	Proceedings of the National Academy of Sciences of the United States of America

Northern Dynasty Mines Inc.	2005	Draft environmental baseline studies, 2004 progress reports: Chapter 8. Geochemical characterization and ADR/ML	Report	Northern Dynasty Mines Inc.
Pacific Fishery Management Council (PFMC)	1999	Pacific Coast Salmon Plan, Fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon and California, as revised through Amendment	Report	PFMC
Poole, G., J. Risley, and M. Hicks	2001	Spatial and temporal patterns of stream temperature (revised)	Government Document	EPA Issue Paper 3, EPA-910-D-01-003

Rico, M., G. Benito, A.R. Salgueiro, A. Díez-Herrero, and H.G. Pereira	2008	Reported tailings dam failures – A review of the European incidents in the worldwide context	Journal Article	Journal of Hazardous Materials
Schaefer, J.F., E. Marsh-Matthews, D.E. Spooner, K.B. Gido and W.J. Matthews	2003	Effects of barriers and thermal refugia on local movement of the threatened leopard darter, *Percina pantherina*	Journal Article	Environmental Biology of Fishes
Stratus Consulting	2010	Hydrologic analysis of the Pebble Deposit area, Alaska	Report	Stratus Consulting Inc.
Suttle, K.B., M.E. Power, J.M. Levine, and C. McNeely	2004	How fine sediment in riverbeds impairs growth and survival of juvenile salmonids	Journal Article	Ecological Applications

Warren, M.L. and M.G. Pardew	1998	Road crossings as barriers to small-stream fish movement	Journal Article	Transactions of the American Fisheries Society
Weber-Scannell, P.K. and L.K. Duffy	2007	Effects of total dissolved solids on aquatic organisms: A review of literature and recommendation for salmonid species	Journal Article	American Journal of Environmental Sciences

Wigington Jr., P.J., J.L. Ebersole, M.E. Colvin, B. Miller, B. Hansen, H. Lavigne, D. White, J.P. Baker, M.R. Church, S.G. Leibowitz, J.R. Brooks, M.A. Cairns, and J.E. Compton	2006	Coho salmon dependence on intermittent streams	Journal Article	Frontiers in Ecology and the Environment
Winston M.R., C.M. Taylor, and J. Pigg	1991	Upstream extirpation of four minnow species due to damming of a prairie stream	Journal Article	Transactions of the American Fisheries Society

Woodward, D.F., J.K. Goldstein, A.M. Farag, and W.G. Brunbaugh	1997	Cutthroat trout avoidance of metals and conditions characteristic of a mining waste site: Coeur d'Alene River, Idaho	Journal Article	Transactions of the American Fisheries Society
Woody, C.A. and S.L. O'Neal	2010	Fish surveys in headwater streams of the Nushagak and Kvichak River drainages Bristol Bay, Alaska, 2008-2010	Report	The Nature Conservancy
Xiao, H.Y., W.B. Zhou, F.P. Zeng, and D.S. Wu	2010	Water chemistry and heavy metal distribution in an AMD highly contaminated river	Journal Article	Environmental Earth Sciences

Zamzow, K.	2009	Impacts of exploration on water chemistry and adequancy of baseline water characterization at the Pebble Prospect 1988-2008	Report	Center for Science in Public Participation
Zamzow, K.	2010	Potential impacts to water during exploration at the Pebble Prospect, Alaska	Report	Redox Resources

Pages (and Volume(issue) if applicable)	Abstract
129(1): 60-76	The effects of acidification in lotic systems are not well documented. Spatial and temporal variability of habitat and water quality complicate the evaluation of acidification effects in streams and rivers. The Neversink River in the Catskill Mountains of southeastern New York, the tributaries of which vary from well buffered to severely acidified, provided an opportunity to investigate the extent and magnitude of acidification effects on fish communities of headwater systems. Composition of fish communities, water quality, stream hydrology, stream habitat, and physiographic factors were characterized from 1991 to 1995 at 16 first- to fourth-order sites in the basin. Correlation and regression analyses were used to develop empirical models and to assess the relations among fish species richness, total fish density, and total fish biomass and environmental variables. Chronic and episodic acidification and elevated concentrations of inorganic monomeric aluminum were common, and fish populations were rare or absent from several sites in the upper reaches of the basin; as many as six fish species were collected from sites in the lower reaches of the basin. Species distributions and species richness were most highly related to stream pH, acid-neutralizing capacity (ANC), inorganic monomeric aluminum (Al_{im}), calcium $(Ca)^{2+}$, and potassium $(K)^{+*}$ concentrations, site elevation, watershed drainage area, and water temperature. Fish density was most highly related to stream pH, Al_{im}, ANC, K^{+}, Ca^{2+}, and magnesium $(Mg)^{2+}$ concentrations. Fish biomass, unlike species richness and fish density, was most highly related to physical habitat characteristics, water temperature, and concentrations of Mg^{2+} and silicon. Acidity characteristics were of secondary importance to fish biomass at all but the most severely acidified sites. Our results indicate that (1) the total biomass of fish communities was not seriously affected at moderately to strongly acidified sites; (2) species richness and total density of fish were adversely affected at strongly to severely acidified sites; and (3) possible changes in competitive interactions may mitigate negative effects of acidification on fish communities in parts of the Neversink River Basin.
22(10): 2266-2274	The sublethal effects of copper on the sensory physiology of juvenile coho salmon (*Oncorhynchus kisutch*) were evaluated. In vivo field potential recordings from the olfactory epithelium (electro-olfactograms) were used to measure the impacts of copper on the responses of olfactory receptor neurons to natural odorants (L-serine and taurocholic acid) and an odorant mixture (L-arginine, L-aspartic acid, L-leucine, and L-serine) over a range of stimulus concentrations. Increases in copper impaired the neurophysiological response to all odorants within 10 min of exposure. The inhibitory effects of copper (1.0 - 20.0 µg/L) were dose-dependent and they were not influenced by water hardness. Toxicity thresholds for the different receptor pathways were determined by using the benchmark dose method and found to be similar (a 2.3 - 3.0 µg/L increase in total dissolved copper over background). Collectively, examination of these data indicates that copper is broadly toxic to the salmon olfactory nervous system. Consequently, short-term influxes of copper to surface waters may interfere with olfactory-mediated behaviors that are critical for the survival and migratory success of wild salmonids.

57: 2032-2043	The abandoned copper mine at Britannia Beach, British Columbia, has been releasing acid mine drainage (AMD) into Howe Sound for many years. To assess the impacts of AMD on juvenile salmonids in the Britannia Creek estuary, we compared fish abundance, distribution, and survival at contaminated sites near the creek with uncontaminated areas in Howe Sound. Water quality near Britannia Creek was poor, particularly in spring when dissolved Cu exceeded 1.0 $mg \cdot L^{-1}$ and pH was less than 6. Beach seine surveys conducted during April–August 1997 and March–May 1998 showed that chum salmon (*Oncorhynchus keta*) fry abundance was significantly lower near Britannia Creek mouth ($0–1.2 \cdot 100\ m^{-2}$) than in reference areas ($11.5–31.4 \cdot 100\ m^{-2}$). Laboratory bioassays confirmed that AMD from Britannia Mine was toxic to juvenile chinook (*Oncorhynchus tshawytscha*) and chum salmon (96-h LC50 = 0.7–29.7% in fresh- water and 12.6–62.2% in 10 ppt water). Chinook salmon smolts transplanted to surface cages near Britannia Creek experienced 100% mortality within 2 days. These results demonstrated that juvenile salmonids are vulnerable to AMD from Britannia Creek: their abundance peaks during spring when Cu concentrations are highest and toxicity is greatest in surface freshwater, which matches their preferred vertical distribution.
74	Protection of Washington State's salmonids requires that transportation officials consider the effect of suspended sediments released into streams during transportation projects. Many state and provincial criteria are based on a threshold of exceedance for background levels of turbidity. However, determining natural background levels of turbidity is a difficult endeavor. The inconsistent correlation between turbidity measurements and mass of suspended solids, as well as the difficulty in achieving repeatability using turbidimeters contributes to concerns that turbidity may not be a consistent and reliable tool determining the effects of suspended solids on salmonids. Other factors, such as life stage, time of year, size and angularity of sediment, availability of off-channel and tributary habitat, and composition of sediment may be more telling in determining the effect of sediment on salmonids in Northwestern rivers. For short-term construction projects, operators will need to measure background turbidities on a case by case basis to determine if they are exceeding regulations. However, transportation projects may also produce long-term, chronic effects. To adequately protect salmonids during their freshwater residence, TSS data on physiological, behavioral, and habitat effects should be viewed in a layer context, incorporating both the spatial geometry of suitable habitat and the temporal changes associated with life history, year class, and climate variability. Spatial and temporal considerations provide the foundation to decipher legacy effects as well as cumulative and synergistic effects on salmonid protection and recovery.

18(2): 299-307	This study quantitatively evaluated the relationships among As, Co, and Cu concentrations in exposure media (surface water, sediment, and *aufwuchs*), As, Co, and Cu concentrations in aquatic macroinvertebrates, and invertebrate community structure in a mine-affected stream. Concentrations of As, Co, and Cu were significantly elevated in both exposure media and invertebrate tissue downstream from the mine. Copper in invertebrates was significantly correlated only with Cu in *aufwuchs*, and Co in invertebrates was significantly correlated only with dissolved Co in water, suggesting different mechanisms of invertebrate accumulation for these two metals. The invertebrate community was severely affected downstream from the mine, with a loss of metals-sensitive species and reductions in both total biomass and number of species. Total abundance was not affected. Principal components analysis was performed on the invertebrate community data to develop a simplified description of community response to mine inputs. Based on this index, metal concentrations in invertebrates were poor predictors of community structure. Copper concentrations in water, combined with an estimate of invertebrate drift from clean tributaries, were statistically significant predictors of community structure.
42: 1410-1417	The territorial, gill-flaring, and feeding behavior of juvenile coho salmon (*Oncorhynchus kisutch*) in a laboratory stream was disrupted by short-term exposure to suspended sediment pulses. At the higher turbidities tested (30 and 60 nephelometric turbidity units (NTU)), dominance hierarchies broke down, territories were not defended, and gill flaring occurred more frequently. Only after return to lower turbidities (0-20 NTU) was social organization reestablished. The reaction distance of the fish to adult brine shrimp decreased significantly in turbid water (30 and 60 NTU) as did capture success per strike and the percentage of prey ingested. Implications of these behavioral modifications suggest that the fitness of salmonid populations exposed to short-term pulses of suspended sediment may be impaired.
4: 371-374	Some water quality standards established by the states permit only minor increases in suspended sediment when background turbidity is low, allow greater absolute increases as background levels rise, and do not consider acclimation of stream biota to high turbidity. Juvenile coho salmon (*Oncorhynchus kisutch*) were subjected to experimentally elevated concentrations of suspended sediment and did not avoid moderate turbidity increases when background levels were low, but exhibited significant avoidance when turbidity exceeded a threshold that was relatively high (>70 NTU) and was varied according to previous suspended sediment exposure.
14: 289-295	The effect of an embedded substratum on emigration and growth in juvenile brown trout was investigated in an artificial stream with sand added to produce sections of embedded or nonembedded substratum. Fish were allowed to leave the sections and were caught daily in a downstream trap. After catching and counting, fish were put back in their original section in order to keep the same amount of fish. Captures were high only on the first days after fish release. During the first 6 days after fish release, downstream-moving fish were more numerous in the embedded than in the nonembedded sections. The embedded substratum significantly decreased the final mean body weight and condition factor and increased heterogeneity in fish size. We suggest that a decrease in the habitat carrying capacity for juveniles could be the main factor explaining this result.

1(1): 15-21	The soils forming on waste rock dump surfaces at the Bingham Canyon Mine have paste pH values ranging from 2.08 to 7.91. Paste conductivity, a measure of soil salinity, varies between 22 and 8750 $\mu S\ cm^{-1}$. The primary controls on waste rock soil pH and salinity are the sulphide distribution in the waste rock, the amount of limestone present and the age of the waste rock dump surface. The average pH of recently exposed waste rock is 7.0 and the average conductivity is 1120 $\mu S\ cm^{-1}$. Within six years of placement on the waste rock dumps the average pH declines to 4.7, further decreasing to 3.7 after 50 years. The average conductivity increases to 3000 $\mu S\ cm^{-1}$ within six years but then declines to 855 $\mu S\ cm^{-1}$ after 50 years. The sharp drop in pH, and the peak in salinity shortly after the waste rock is placed on the dumps, reflects the rapid release of acidity and sulphate caused by oxidation of newly exposed pyrite. The salinity of the soils begins to decline as pyrite becomes depleted and sulphate is flushed from the soil by infiltration and runoff more rapidly than it is replenished by sulphide oxidation.
22	The proposed Pebble Project, by Northern Dynasty Mines, Inc. (NDM) and Anglo American plc, is a low grade copper-gold-molybdenum sulfide deposit in SW Alaska. The deposit outcrops on the surface (Pebble West, PW), requiring open pit mining methods, and extends under non-ore bearing rocks (Pebble East, PE), requiring underground block caving. The deposit sits on a drainage divide, with the Upper Talarik (UT) River draining east and south, and the North Fork (NFK) and South Fork (SFK) Koktuli rivers draining west and southwest, respectively. Mining of the ore deposit would result in an open pit and underground mine at the headwaters of the SFK and UT watersheds. The mine waste (tailings and waste rock) would be stored in two Tailings Storage Facilities located in the SFK and NFK watersheds. The PW open pit is projected to have a pit lake. Pit water can be impacted by the rock remaining in the pit walls, especially that material exposed by fracturing and rubbilization due to mining. If the water in the pit is of poor quality from decomposition of sulfide minerals, and the hydrology facilitates flow down gradient to ground and surface waters, there could be long term impacts to water off the minesite. Subsidence will likely occur due to block caving at PE. Subsidence at the surface allows water to enter the underground mine from above and contact broken rock that will remain underground. The rock in the remaining underground workings in the deposit will be mineralized. This could lead to decomposition of sulfide minerals and acid mine drainage. If a flow path exists from the mine workings to ground and surface waters down gradient from the mine, migration of contamination off the mine site would be a long term issue. Tailings dams will be built to contain waste, several with heights over 700 feet. Tailings dams must stand in perpituity. A large earthquake might cause failure of a tailings dam. A catastrophic release of a large amount of tailings could lead to long term environmental damage with huge cleanup costs. The probability of such failure is low, but the consequences are very high. A 104-mile industrial road will connect the mine and the port sites, with a concentrate pipeline parallel to the road. The pipeline will be engineered with leak detection systems and shutoff valves, though material between the shutoff valve and a break can still leak from a ruptured pipeline. Concentrates are moved via conveyor onto a ship for transport to a smelter. Concentrate spills during ship loading has been an issue in the past with similar loading facilities in Alaska. Finally, mines must be 'designed for closure.' While Alaska reclamation law requires adequate financial surety for closure be provided to the bond holding agency, regulatory agencies have a history of underestimating closure costs for metal mines. Mine closure typically costs tens to hundreds of millions of dollars, a significant liability to the regulatory agency, and by association to the taxpayer. Regulatory agencies in Alaska now accept corporate guarantees which are not backed by any tangible security.

110: 281-286	Juvenile coho salmon (*Oncorhynchus kisutch*) production (tissue elaboration) was monitored in 12 laboratory streams under six replicate treatment levels of fine sedimentation. Increasing sedimentation supressed fish production. Our data confirm that habitats of salmonid juveniles, as well as spawning areas, should be protected against fine sediments. Substrate Score, a visual technique for evaluating stream substrate quality, correlated closely with both the geometric mean particle size of the substrate and fish production, and can be easily applied in the field.
73(1): 91-98	1. The uptake of heavy metals via the alimentary tract can be an important factor for the metal budget of fish. 2. Concepts such as biomagnification, bioaccumulation, biotransference, or concentration factors, convey little information about the real threat originating from heavy metals in an aquatic food chain. 3. In polluted aquatic ecosystems the transfer of metals through food chains can be high enough to bring about harmful concentrations in the tissues of fish. This relationship is called the food chain effect. 4. Two kinds of ecological factors influence the food chain effect: firstly, high levels of contamination of the food, and, secondly, the reduction of species diversity. When susceptible species are eliminated, metal-tolerant food organisms may become dominant. Their tolerance may be based either on their ability to accumulate excessive amounts of metals or to exclude heavy metals from the tissues. These two strategies represent feedback mechanisms which may enhance or weaken the food chain effect. 5. It is concluded that future investigations on transference of heavy metals to fish must take into more careful consideration the specific ecological situation of a given environment.
31-36	Are tailings impoundments the most challenging facilities that geotechnical engineers will encounter during their careers? Whether one answers yes or no, there can be no argument that these facilities are indeed challenging and that there is little room for error in their design and stewardship. Where more room has been sought, failures have been the all too frequent result. Can these failures be avoided? Many geotechnical practitioners get involved with mine tailings impoundments. These practitioners should make themselves familiar with the extensive and, unfortunately, growing database of mine tailings impoundment failure case histories. Many of the failures in the database have been the direct result of a geotechnical failure mode; failure modes that should be less common in modern geotechnical practice. The implications to geotechnical design practice from the trends indicated by the database are clear.
39(10): 1107-1116	Mining of massive sulfide deposits in southwestern Spain extending back to the Copper and Bronze Ages has resulted in the pollution of the Rio Tinto fluvial-estuarine complex, the site of Columbus' departure for the New World in 1492. Additional sources of potential pollution include the large industrial complex at Huelva near the lower portion of the estuary. Extensive analysis of surface sediment samples and cores has established that there are no geographic trends in the distribution of the pollutants, which include Cu, Fe, Pb, Zn, Ti, Ba, Cr, V and Co. These data have, however, demonstrated that tidal flux within the estuary carries phosphorus and perhaps other elements from the industrial complex at Huelva to the tidal limit of the system, several kilometers upstream from the discharge site. Radiometric analysis of short cores shows that sedimentation rates over at least the past couple of centuries have been about 0.3 cm/ year. These data and that from a single deep core demonstrate that the estuary was polluted from mining activity long before the large-scale operations began in the late nineteenth century.

26: 590-602	The impact of mining and smelting of metal ores on environmental quality is described. Mines produce large amounts of waste because the ore is only a small fraction of the total volume of the mined material. In the metal industry, production of Cu, Pb, and Zn causes the greatest degradation of the environment. Copper mining produces extensive mine wastes and tailings and Cu smelting emits approximately 0.11 Mg of S per Mg of Cu produced in the USA. Zinc and Pb smelters release large quantities of Cd and Pb into the environment. Metal smelting and refining produce gaseous (CO_2, SO_2, NO_x, etc.) and particulate matter emissions, sewage waters, and solid wastes. Soil contamination with trace metals is considered a serious problem related to smelting; however, mining and smelting are not main sources of global metal input into soils. Other sources like discarded manufactured products, coal ash, agriculture, and transportation take a lead. Smelters are the main sources of atmospheric emissions of As, Cu, Cd, Sb, and Zn on a global scale and they contribute substantially to the overall emissions of Cr, Pb, Se, and Ni. A quantitative evaluation of the environmental health effects of mining and smelting is difficult because of the complexity of factors involved and lack of consistent methodology. Nevertheless, the case studies described indicate that negative health effects could arise from Pb mining and smelting. Risk assessment revealed that food chain contamination by Cd from soils contaminated by smelting is very unlikely under the western diet.
4	None
41(5): 1109-1115	The effects of climate warming on the thermal habitat of 57 species of fish of the U.S. were estimated using results for a doubling of atmospheric carbon dioxide that were predicted by the Canadian Climate Center general circulation model. Baseline water temperature conditions were calculated from data collected at 1,700 U.S. Geological Survey stream monitoring stations across the U.S. Water temperatures after predicted climate change were obtained by multiplying air temperature changes by 0.9, a factor based on several field studies, and adding them to baseline water temperatures at stations in corresponding grid cells. Results indicated that habitat for cold and cool water fish would be reduced by -5O%, and that this effect would be distributed throughout the existing range of these species. Habitat losses were greater among species with smaller initial distributions and in geographic regions with the greatest warming (e.g. the central Midwest). Results for warm water fish habitat were less certain because of the poor state of knowledge regarding their high and low temperature tolerances; however, the habitat of many species of this thermal guild likely will also be substantially reduced by climate warming, whereas the habitat of other species will be increased.

212	Ecological risk assessment (ERA) has become an essential tool for determining impacts to biological receptors as a result of contamination from metal mining facilities (Brumbaugh et al. 1994, Canfield et al. 1994, Ingersoll et al. 1994, Kemble et al. 1994, Pascoe and DalSoglio 1994, Pascoe et al. 1994, Linkov et al. 2002). The United States Environmental Protection Agency (EPA) Risk Assessment Forum developed the Framework for Metals Risk Assessment (2007a), which is a science-based document that addresses the special attributes and behaviors of metals and metal compounds to be considered when assessing their human health and ecological risks. To date, efforts have been designed to address the impacts or risks posed by metals contamination subsequent to mining operations. Few, if any, ERAs have been directed at pre-mining impacts. Smith (2007) provided strategies to predict metal mobility at mining sites through evaluation of source characterization, geoenvironmental models, geoavailability, and metals speciation; controlling physicochemical attributes (e.g., solubility, pH, sorption) in aqueous environments are discussed relative to their potential to alter metals bioavailability. The relevance of historical information on metals contamination associated with other mine sites, along with the potential for acid mine drainage (AMD) and metals release and exposure, based on review of the baseline data and geochemical characteristics at a site, have been used to develop both quantitative and qualitative predictions of risk. The present ERA is designed to analyze and portray the potential risks to globally significant salmon resources of the Nushagak-Mulchatna, and Kvichak river drainages (proximal headwater areas) as a result of large-scale mining and associated facilities. These risks include both physical destruction and alteration of salmon habitat, in addition to probable effects from changes to water chemistry and other supporting habitat as a result of AMD and the influx of metals within the aquatic ecosystem from various sources. Although the ERA generally presents impacts to salmon from loss of food resources such as benthic invertebrates, it does not focus on specific effects to these fauna. Similarly, although risks to non-anadromous fish within potentially affected stream segments may be similar to salmon, these taxa are not addressed individually within the ERA.
28: 15-29	A marked vertical trend of increasing temperature and dissolved metal concentrations is observed in the monimolimnia of some meromictic pit lakes of the Iberian Pyrite Belt (IPS) in SW Spain. Temperature differences between the chemocline and the pit lake bottom can be as high as 15°C (e.g. Herrerias), and the respective concentration of some metals (e.g., Fe) and metalloids (e.g., As) can increase by several orders of magnitude (e.g., Cueva de la Mora). The redox conditions also change drastically from the upper and oxygenated mixolimnion (strongly oxidizing) to the lower and anoxic monimolimnion (moderately reducing). Processes such as the inflow of metal sulphate laden ground water from flooded shafts and galleries, and other factors such as the pit geometry or the relative depth of the lakes, must be considered to account for the observed stratification pattern. The vertical profiles of physico-chemical parameters and water chemistry obtained in Cueva de la Mora and other meromictic pit lakes of the IPB are also compatible with a reactive bottom in which several geochemical and microbial reactions (including reductive dissolution of Fe^{3+} minerals, bacterial reduction of Fe^{3+} and $S0_4^{2-}$ in pore waters within the sediments, and decomposition of organic matter) could be taking place.

66(6): 1762-1768	We constructed a patch dynamics model which can be used to simulate the changing sizes of resident populations in a series of interconnected habitat patches. We applied the model to white-footed mice (*Peromyscus leucopus*) inhabiting patches of forest in an agricultural landscape. The model predicts that mouse populations in isolated woodlots have lower growth rates and are thus more prone to extinction than those in connected woodlots. Field data support this prediction.
132: 450-467	Abandoned tailings and mine adits are located throughout the Boulder River watershed in Montana. In this watershed, all species of fish are absent from some tributary reaches near mine sources; however, populations of brook trout *Salvelinus fontitalis*, rainbow trout *Oncorhynchus mykiss*, and cut-throat trout *O. clarki* are found further downstream. Multiple methods must be used to investigate the effects of metals released by past mining activity because the effects on aquatic life may range in severity, depending on the proximity of mine sources. Therefore, we used three types of effects -- those on fish population levels (as measured by survival), those on biomass and density, and those at the level of the individual (as measured by increases in metallothionein, products of lipid peroxidation, and increases in concentrations of tissue metals) -- to assess the aquatic health of the Boulder River watershed. Elevated concentrations of Cd, Cu, and Zn in the water column were associated with increased mortality of trout at sites located near mine waste sources. The hypertrophy (swelling), degeneration (dying), and necrosis of epithelial cells observed in the gills support our conclusion that the cause of death was related to metals in the water column. At a site further downstream (lower Cataract Creek), we observed impaired health of resident trout, as well as effects on biomass and density (measured as decreases in the kilograms of trout per hectare and the number per 300 m) and effects at the individual level, including increases in metallothionein, products of lipid peroxidation, and tissue concentrations of metals.
128: 121-129	Spawning migration of adult male chinook salmon *Oncorhynchus tshawytscha* was monitored by radio telemetry to determine their response to the presence of metals contamination in the South Fork of the Coeur d'Alene River, Idaho. The North Fork of the Coeur d'Alene River is relatively free of metals contamination and was used as a control. In all, 45 chinook salmon were transported from their natal stream, Wolf Lodge Creek, tagged with radio transmitters, and released in the Coeur d'Alene River 2 km downstream of the confluence of the South Fork and the North Fork of the Coeur d'Alene River. Fixed telemetry receivers were used to monitor the upstream movement of the tagged chinook salmon through the confluence area for 3 weeks after release. During this period, general water quality and metals concentrations were monitored in the study area. Of the 23 chinook salmon observed to move upstream from the release site and through the confluence area, the majority (16 fish, 70%) moved up the North Fork, and only 7 fish (30%) moved up the South Fork, where greater metals concentrations were observed. Our results agree with laboratory findings and suggest that natural fish populations will avoid tributaries with high metals contamination.

25(1): 15-21	We used historical cannery records and current escapement and harvest records to estimate historical and current salmon escapement to western North American river systems, in order to determine the biomass and marine-derived nitrogen and phosphorous levels delivered by adult salmon, and the deficits corresponding to the diminished returns of adult salmon over the past century. We have estimated the historic biomass of salmon returning to the Pacific Northwest (Washington, Oregon, Idaho, and California) to be 160-226 million kg. The number of fish now returning to these rivers has a biomass of 11.8-13.7 million kg. These numbers indicate that just 6-7% of the marine-derived nitrogen and phosphorous once delivered to the rivers of the Pacific Northwest is currently reaching those streams. This nutrient deficit may be one indication of ecosystem failure that has contributed to the downward spiral of salmonid abundance and diversity in general, further diminishing the possibility of salmon population recovery to self-sustaining levels.
29(6): 763-781	Active exchanges of water and dissolved material between the stream and groundwater in many porous sand- and gravel-bed rivers create a dynamic ecotone called the hyporheic zone. Because it lies between two heavily exploited freshwater resources—rivers and groundwater—the hyporheic zone is vulnerable to impacts coming to it through both of these habitats. This review focuses on the direct and indirect effects of human activity on ecosystem functions of the hyporheic zone. River regulation, mining, agriculture, urban, and industrial activities all have the potential to impair interstitial bacterial and invertebrate biota and disrupt the hydrological connections between the hyporheic zone and stream, groundwater, riparian, and floodplain ecosystems. Until recently, our scientific ignorance of hyporheic processes has perhaps excused the inclusion of this ecotone in river management policy. However, this no longer is the case as we become increasingly aware of the central role that the hyporheic zone plays in the maintenance of water quality and as a habitat and refuge for fauna. To fully understand the impacts of human activity on the hyporheic zone, river managers need to work with scientists to conduct long-term studies over large stretches of river. River rehabilitation and protection strategies need to prevent the degradation of linkages between the hyporheic zone and surrounding habitats while ensuring that it remains isolated from toxicants. Strategies that prevent anthropogenic restriction of exchanges may include the periodic release of environmental flows to flush silt and reoxygenate sediments, maintenance of riparian buffers, effective land use practices, and suitable ground-water and surface water extraction policies.
18(9): 1972-1978	Behavioral avoidance of copper (Cu), cobalt (Co), and a Cu and Co mixture in soft water differed greatly between rainbow trout (*Oncorhynchus mykiss*) and chinook salmon (*O. tshawytscha*). Chinook salmon avoided at least 0.7µ * Cu/L, 24 µ* Co/L, and the mixture of 1.0 *g Cu/L and 0.9 *g Co/L, whereas rainbow trout avoided at least 1.6 *g Cu/L, 180 *g Co/L, and the mixture of 2.6 µ* Cu/L and 2.4 µ* Co/L. Chinook salmon were also more sensitive to the toxic effects of Cu in that they failed to avoid *4 *g Cu/L, whereas rainbow trout failed to avoid *80 *g Cu/L. Furthermore, following acclimation to 2 _xFFFF_µg Cu/L, rainbow trout avoided 4 *g Cu/L and preferred clean water, but chinook salmon failed to avoid any Cu concentrations and did not prefer clean water. The failure to avoid high concentrations of metals by both species suggests that the sensory mechanism responsible for avoidance responses was impaired. Exposure to Cu concentrations that were not avoided could result in lethality from prolonged Cu exposure or in impairment of sensory-dependent behaviors that are essential for survival and reproduction.

20	The freshwater streams of the Bristol Bay drainages support important subsistence and commercial salmon fisheries and internationally-famous sport fisheries for both resident species and salmon. Northern Dynasty Mines, Inc. (NDM) has proposed to mine a metallic sulfide deposit at the headwaters of some of these streams. The project, referred to as Pebble Mine, will have a preliminary lifespan of 40 to 50 years, or even longer. Applications filed by NDM in 2006 indicate that the proposed project will leave permanent landscape features affecting some thirty square miles, including two tailings ponds that will house billions of tons of mine tailings which will include toxic materials. The project will also include a 104-mile access road, with a slurry line and a water line that will directly affect at least 12.5 square miles and a power transmission line. The 2006 applications help identify potential impacts on the fish habitat and fisheries. Categories of these potential impacts of Pebble Mine on fish habitat and fishery resources include: direct, indirect, and cumulative effects. Direct impacts will result from the approximately 30 square mile footprint of the mine, processing plant, and tailings ponds; more than 60 lineal miles of mainstem streams--plus the adjacent tributaries and wetlands--that will be totally or partially dewatered; the 12.5 square miles or 8,000 acres of disturbance from the access road; port facilities; and, power production and power supply lines. Siltation caused by road-building activities will smother fish food organisms and incubating eggs and alevins. Direct effects associated with the road also include fragmentation of aquatic, riparian, and terrestrial habitats. Indirect impacts will include increased pressure on, and competition for, fish and wildlife resources, because of the increased access to the area and increased population. Cumulative impacts will include long-term, multi-year losses of fish production and stream productivity. Over time, bridges and culverts in the access road can deteriorate and interfere with juvenile or adult fish migration between important habitats. Dust and silt from the road during the life of the project or leakage from the slurry line may smother fish food organisms and incubating fish eggs and could wash downstream to affect spawning and rearing habitat in Iliamna Lake. In addition, the weight of the roadbed and traffic can be expected to compact the soil and alter the movement of groundwater which could disrupt beach spawning by sockeye salmon in Iliamna Lake. Although the access road and other support roads will be constructed for the proposed Pebble Mine, they will also provide access to the area by other residential, commercial, and recreational users. The human population and activities can be expected to increase, and off road, all terrain vehicle use will expand into areas not previously accessible. The impact will extend much beyond the footprint of the road itself. Any real or perceived impact from the proposed Pebble Mine on Bristol Bay salmon populations will have the probability of destroying the high-

28: 30-49	Seepage water and drainage water geochemistry (pH, EC, O2, redox, alkalinity, dissolved cations and trace metals, major anions, total element concentrations) were studied at two active sulphide mine tailings impoundments in Finland (the Hitura Ni mine and Luikonlahti Cu mine/talc processing plant). The data were used to assess the factors influencing tailings seepage quality and to identify constraints for water treatment. Changes in seepage water quality after equilibration with atmospheric conditions were evaluated based on geochemical modelling. At Luikonlahti, annual and seasonal changes were also studied. Seepage quality was largely influenced by the tailings mineralogy, and the serpentine-rich, low sulphide Hitura tailings produced neutral mine drainage with high Ni. In contrast, drainage from the high sulphide, multi-metal tailings of Luikonlahti represented typical acid mine drainage with elevated contents of Zn, Ni, Cu, and Co. Other factors affecting the seepage quality included weathering of the tailings along the seepage flow path, process water input, local hydrological settings, and structural changes in the tailings impoundment. Geochemical modelling showed that pH increased and some heavy metals were adsorbed to Fe precipitates after net alkaline waters equilibrated with the atmosphere. In the net acidic waters, pH decreased and no adsorption occurred. A combination of aerobic and anaerobic treatments is proposed for Hitura seepages to decrease the sulphate and metal loading. For Luikonlahti, prolonged monitoring of the seepage quality is suggested instead of treatment, since the water quality is still adjusting to recent modifications to the tailings impoundment.

18(2): 221-239	The Aznalcollar tailings dam at Boliden Apirsa's Aznalcollar/Los Frailes Ag–Cu–Pb–Zn mine 45 km west of Seville, Spain, was breached on 25 April 1998, flooding approximately 4600 hectares of land along the Rıos Agrio and Guadiamar with approximately 5.5 million cubic meters of acidic water and 1.3x10^6 cubic m of heavy metal-bearing tailings. Most of the deposited tailings and approximately 4.7X10^6 cubic m of contaminated soils were removed to the Aznalcollar open pit during clean-up work undertaken immediately after the spill until January 1999. Detailed geomorphological and geochemical surveys of the post-clean-up channel, floodplain and valley floor, and sediment and water sampling, were carried out in January and May 1999 at 6 reaches representative of the types of river channel and floodplain environments in the Rıo Guadiamar catchment affected by the spill. The collected data show that the clean-up operations removed enough spill-deposited sediment to achieve pre-spill metal (Ag, As, Cd, Cu, Pb, Sb, Tl, Zn) concentrations in surface sediment. These concentrations, however, are still elevated above pre-mining concentrations, and emphasise that mining continues to contaminate the Agrio-Guadiamar river system. Dilution by relatively uncontaminated sediment appears to reduce metal concentrations downstream but increases in metal and As concentrations occur downstream, presumably as a result of factors such as sewage and agriculture. River water samples collected in May 1999 have significantly greater dissolved concentrations of metals and As than those from January 1999, probably due to greater sulphide oxidation from residual tailings with concomitant release of metals in the warmer early summer months. These concentrations are reduced downstream, probably by a combination of dilution and removal of metals by mineral precipitation. Single chemical extractions (de-ionised water, CaCl2 0.01 mol/l, CH3COONH4 1 M, CH3COONa 1 M and ammonium oxalate 0.2 M) on alluvial samples from reaches 1 and 6, the tailings, pre-spill alluvium and marl have shown that the order of sediment-borne contaminant mobility is generally Zn>Cd>Cu>Pb>As. Pb and As are relatively immobile except possibly under reducing conditions. Much of the highly contaminated sediment remaining in the floodplain and channel still contains a large proportion of tailings-related sulphide minerals which are potentially reactive and may continue to release contaminants to the Agrio–Guadiamar river system. Our work emphasises the need for pre-mining geomorphological and geochemical data, and an assessment of potential contributions of contaminants to river systems from other, non-mining sources.

10	As long linear ecosystems, rivers and streams are particularly vulnerable to fragmentation. There is growing concern about the role of road crossings – and especially culverts – in altering habitats and disrupting river and stream continuity. Most of the culverts currently in place were designed with the principal objective of moving water across a road alignment. Little consideration was given to ecosystem processes such as the natural hydrology, sediment transport, fish and wildlife passage, or the movement of woody debris. It is not surprising then that many culverts significantly disrupt the movement of aquatic organisms. Survival of individual animals, facilitation of reproduction, and the maintenance of population continuity are important functions of movement at a population level. Dispersal of individuals provides a mechanism for regulating population density. These dispersing individuals maintain gene flow among populations and may supplement populations where recruitment is unable to keep pace with the loss of individuals. For many small species (especially invertebrates), dispersal of individuals provides a mechanism for colonizing habitat, allowing local populations to come and go as habitat is created or eliminated, while maintaining viable regional populations. Much attention has been focused on passage for migratory fish, especially in the northwestern U.S. In some cases, considerable resources have been invested in projects addressing fish passage only to find that accommodations made for adults did not address the needs of juvenile fish. Long-term conservation of fish resources will depend not only on passage for both adult and juvenile fish but also on maintenance of healthy stream and river ecosystems. Essential to this approach is a focus on habitat quality and strategies for aquatic organism passage based on communities rather than individual species. Without an ecosystem-based approach to river and stream crossings we will be at risk of facilitating passage for particular fish species while at the same time undermining the ecological integrity of the ecosystems on which these fish depend. Stream simulation is an approach to culvert design that both avoids flow constriction during normal conditions and creates a stream channel within culverts that resists scouring during flood events. Designing culverts to avoid channel constriction and to maintain appropriate channel conditions within the structure is a relatively simple and effective approach for accommodating the normal movements of aquatic organisms and preserving (or restoring) many ecosystem processes that maintain habitats and aquatic animal populations. Road networks and river systems share several things in common. Both are long, linear features of the landscape. Transporting materials (and organisms) is fundamental to how they function. Connectivity is key to the continued functioning of both systems. Ultimately, our goal should be to create a transportation infrastructure that does not fragment or undermine the essential ecological infrastructure of the land
130: 1106-1115	Much research has been devoted to the effects of acidic runoff episodes on populations of brook trout *Salvelinus fontinalis*. Less is known about slimy sculpin *Cottus cognatus* and why their numbers have declined in acidified streams. Adult tolerance of low pH and aluminum (Al) toxicity is similar in these two species. Slimy sculpin spawn in the spring, when high stream flows elevate concentrations of toxic Al and decrease stream pH in acid-sensitive watersheds. We hypothesized that acidic episodes in spring were a source of stress for slimy sculpin and hindered their reproduction. We tested this hypothesis by examining the mortality, behavior, whole-body sodium concentrations, and spawning among slimy sculpin exposed to ambient conditions during the spring spawning period in two Pennsylvania streams, Stone Run (an episodically acidified stream that formerly contained slimy sculpin) and Benner Run (a stream with slimy sculpin that does not experience severe acidic episodes). Our hypothesis was supported by the higher mortality, hypoactivity, lower body sodium concentrations, and lack of spawning among slimy sculpin in Stone Run relative to those in Benner Run. Reproductive disturbance caused by stressful concen- trations of Al and hydrogen ions may have led to the recruitment failure and collapse of the slimy sculpin population in Stone Run.

22(4): 429-440	Little is known of how fish respond to the hydraulic environment associated with diversion or bypass structures at hydroelectric power installations. To address this lack of knowledge, this paper presents results from a study to assess how three species of Pacific salmonid smolt (*Oncorhynchus* spp.) responded to distinct gradients of velocity and depth associated with two submerged weirs as they passed through an experimental flume at McNary Dam (Columbia River, USA) under illuminated and dark conditions. Migrating smolts entered one of two available treatment channels as coherent schools from which individuals would either disassociate from the group and pass over the weirs, or would reject them by swimming upstream. Alternatively, fish maintained position at the upstream end of the flume by swimming into the flow. The response of smolts to velocity and depth gradient and light condition varied between species, and route of passage was influenced by fork length. Initial channel selection and school size was not influenced by weir type, although schools resided longer within the short-weir channel. The majority of smolts (70%) entered the treatment channels facing downstream (negative rheotaxis), but switched orientation at the crests of the weirs. This switch in orientation occurred farther downstream in the short-weir treatment and for the largest smolts. The variation in response of different species of smolts to hydraulic gradients has important implications for the design of screening mechanisms used at hydroelectric power installations to divert migrant juvenile salmonids.
228	None
43(8): 1488-1496	Juvenile rainbow trout were exposed to 25-400 µg copper□L^{-1} for 24h. Water hardness, pH, and alkalinity were varied independently at a constant [Na^+]. Net and unidirectional sodium fluxes were measured in hard and soft, low-alkalinity water and in hard, high-alkalinity water at neutral pH and pH 5.0. In low alkalinity water, Na^+ uptake (J_{in}) was inhibited at copper concentrations as low as 25 µg□L^{-1}, and sodium efflux (J_{out}) was stimulated above 100 µg□L^{-1}. High-alkalinity water significantly reduced the effects of copper on J_{in} and J_{out} but there was no significant effect of increasing water hardness. The effects of pH 5.0 and copper were additive from 25 to 100 µg□L^{-1}, but a pure copper effect was found from 200 to 400 µg□L^{-1}. Fish died when they had lost about 50-55% of their exchangeable Na+ pool. Water hardness and alkalinity had no effect on the apparent uptake of copper, but copper uptake was reduced by about 50% at pH 5.0.

33(10): 2415-2423	We analysed the benthic macroinvertebrate species composition, taxonomic richness (as expected richness for 100 individuals), total abundance and biomass at 117 stream sites in the province of Dalarna. Partial least squares regression models were constructed from observations on undisturbed sites and used to predict these community parameters at sites exposed to elevated levels of copper, zinc, lead and cadmium resulting from leakage from old mine deposits. Species richness at undisturbed sites was positively related to the size of the catchment, pH, channel width, calcium concentration and the proportion of deciduous trees in the riparian zone. In streams with elevated metal concentrations, we found reductions in taxonomic richness for total macroinvertebrates, mayflies, stoneflies and combined EPT (Ephemeroptera, Plecoptera and Trichoptera), but not for that of Tri-choptera nor total abundance or biomass. Copper and zinc were those metals showing strongest negative associations with richness. Some taxa, common at undisturbed sites, were missing at metal-polluted sites. These taxa were the mayflies *Ameletus inopinatus*, *Ephemerella aurivilli* and *Heptagenia* dalecarlica, the stonefly *Protonemura meyeri* and the caddisfly *Apatania* sp.
29: 355-358	A half-century after mine closure, metal contamination from sulfide ore mining in the headwaters continues to impair riparian vegetation and aquatic macroinvertebrates along Soda Butte Creek, Yellowstone National Park. A tailings dam failure in 1950 emplaced metal-rich sediment at high flood-plain levels, above 50 yr to 100 yr flood stages in 1996 and 1997. These large natural floods removed only a small part of the contaminated sediment through bank erosion; they also failed to lower in-channel Cu concentrations, because increased erosion of mine waste during high flows balances increased inputs of uncontaminated sediments, generating no net change in concentrations. Geomorphic processes controlling movement of contaminated sediments indicate that mine impacts will persist for centuries in Soda Butte Creek and imply long-lasting impacts in similarly affected streams worldwide.
31	This report addresses more than a dozen environmental issues arising from the hydrological and geochemical conditions at the proposed Pebble Mine, which would develop a metallic sulfide deposit in the Bristol Bay drainages of Southwest Alaska. These drainages produce a major portion of the world's sockeye salmon supply, important subsistence use, and recreation. The hydrological and geochemical issues fall into two groups. The first is "substantive" issues – e.g. (a) acid mine drainage from unprocessed waste and host rock, mine or pit walls, tailings, tailings storage facilities, and dust; (b) pollution from chemicals used in processing ore, (c) pollution from fuels, oils, greases and antifreeze; (d) pollution from residues of explosives; (e) chemical and bacteriological pollution from sewerage treatment facilities; (f) pollution from herbicides, pesticides and road deicing compounds; etc. The second group is "procedural" issues. They result from (a) inadequate data (or decisions not to release all data) particularly on matters related to hydrology and chemical compositions of rock, potential ore, waste rock, tailings, etc; (b) inadequate sampling techniques, and inadequate protocols for preserving field samples or gathering field or lab data; etc. The procedural issues weave throughout the substantive issues and undermine the ability of the public and their agencies to understand the potential, significant environmental impacts, particularly to water and fish, which will result from Pebble Mine. This report concludes that significant impacts to some of the world's most important fisheries are likely.

	Mineral extraction, whether it be by surface or underground mining in their diverse forms, affects salmonids and their habitats in many ways. Increasing public awareness of the value of aquatic resources has led to legislation designed to protect, restore, or enhance areas that have been or will be mined. This positive trend has also led to a growing body of knowledge about the specific effects of mining-related pollutants on salmon and trout and the mechanisms by which habitat degradation may be reversed. Some of the adverse effects of mining on salmonid habitats are obvious. Placer mining converts natural streams to channels between barren rubble piles; hydraulic mining erodes hillsides and deposits the eroded material into nearby streams. Road building and removal of surface vegetation may also contribute to direct streambed disturbances and sediment influxes. Other influences, however, may be less obvious and much more insidious. One of the principal and most persistent results of mining is acid mine drainage. Both orphaned and currently operated mines may contribute acidic drainage to nearby waters. Acid production can occur in coal deposits by the generation of sulphuric acid or through the action of oxidizing bacteria on pyrite, a common component of the granitic material in which many western ore deposits occur. The consequences of acid drainage are many and they are expressed in a variety of ways. If pH levels are sufficiently low, fish populations may be reduced directly through fish kills or less directly through reduction in the viability of individuals, their gametes, or their progeny. Aquatic invertebrates, an important source of food for many salmonids, may also be affected by acid drainage; they may be directly poisoned or their habitats may be degraded by deposition of ferric hydroxide. In addition, the toxicity of many metallic poisons is increased at low pH levels. Tailings piles and settling ponds also may contribute pollutants. Cyanide, a highly toxic chemical that is often used to recover gold, has sometimes entered streams through failure of settling ponds. Acid drainage through tailings piles contributes metallic pollutants to nearby waterways. Many metals (including arsenic, cadmium, chromium, copper, iron, and uranium) that are either the object of mining or are associated with extraction of other minerals are highly toxic to fish, and their toxicity may be greatly influenced by pH. In many cases, metallic compounds are relatively insoluble in natural waters that are of nearly neutral pH, but become increasingly soluble as acidity increases, thereby increasing the concentration of toxic metal ions.
96: 3455-3462	The Richmond Mine of the Iron Mountain copper deposit contains some of the most acid mine waters ever reported. Values of pH have been measured as low as -3.6, combined metal concentrations as high as 200 g/liter, and sulfate concentrations as high as 760 g/liter. Copious quantities of soluble metal sulfate salts such as melanterite, chalcanthite, coquimbite, rhomboclase, voltaite, copiapite, and halotrichite have been identified, and some of these are forming from negative-pH mine waters. Geochemical calculations show that, under a mine-plugging remediation scenario, these salts would dissolve and the resultant 600,000-m^3 mine pool would have a pH of 1 or less and contain several grams of dissolved metals per liter, much like the current portal effluent water. In the absence of plugging or other at-source control, current weathering rates indicate that the portal effluent will continue for approximately 3,000 years. Other remedial actions have greatly reduced metal loads into downstream drainages and the Sacramento River, primarily by capturing the major acidic discharges and routing them to a lime neutralization plant. Incorporation of geochemical modeling and mineralogical expertise into the decision- making process for remediation can save time, save money, and reduce the likelihood of deleterious consequences.

51	This report presents the preliminary findings of the 2004 study of metal leaching/acid rock drainage (ML/ARD). The results presented in this report are for: • Static acid-generation testing of rock core obtained prior to 2004 (including previous drilling by Cominco Alaska), • Element scans for core collected in 2004 from the Tertiary cover rocks and periphery of the deposit near the eventual pit walls of the mine, and • Static acid-generation testing of metallurgical waste products and water-chemistry analysis from process flowsheet development. The report does not include results from leach tests and kinetic geochemical tests which are currently underway. As such, the data obtained provide an early indication of the possible geochemical nature of mine wastes but do not allow water-quality predictions to be provided.
52	None
33	Stream temperature is an aspect of water quality that affects every aquatic organism. Yet taking that temperature is not as easy as it may seem. Placing a thermometer in a stream and recording the reading are simple enough. The problem is that the result does not represent the entire stream, whose temperatures vary markedly over both time and location. Instead of a single measurement, what is needed is a set of measures that describes a stream's "temperature regime." Even then, the process is complicated. Many factors affect the temperature regime, including climate, riparian or stream bank vegetation, and channel form and structure. The factors with the strongest influence vary from time to time and place to place. What's more, patterns of variation in stream temperature differ depending on the timescale of observation and the size of the area within which temperature is measured. For instance, variation in stream temperature over a single day is apt to differ from variation over an entire year. Similarly, the patterns of temperature observed within a single pool or riffle in a stream are apt to differ completely from the patterns observed along the entire stream course. Stream temperature regimes are difficult to quantify, but available evidence suggests that stream temperature regimes in the Pacific Northwest are now typically different from those that existed before Euro- Americans settled the region. Evidence further shows that a variety of human activities often are responsible for changes in temperature regimes over time and that the effects of human activities often are cumulative: individual land use activities that alone would not substantially alter stream temperature can do so when combined with other activities or with natural disturbances. Alteration of these regimes in turn may contribute to a decline in the family of fish known as salmonids, which until recently has successfully adapted to historical variations in stream temperature. In many streams where large salmon runs once were typical, the temperature regimes now appear inhospitable. Thus, from a scientific perspective, restoration of temperature regimes compatible with desired populations is an important factor in their recovery.

152(2): 846-852	A detailed search and re-evaluation of the known historical cases of tailings dam failure was carried out. A corpus of 147 cases of worldwide tailings dam disasters, from which 26 located in Europe, was compiled in a database. This contains six sections, including dam location, its physical and constructive characteristics, actual and putative failure cause, sludge hydrodynamics, socio-economical consequences and environmental impacts. Europe ranks in second place in reported accidents (18%), more than one third of them in dams 10–20 m high. In Europe, the most common cause of failure is related to unusual rain, whereas there is a lack of occurrences associated with seismic liquefaction, which is the second cause of tailings dam breakage elsewhere in the world. Moreover, over 90% of incidents occurred in active mines, and only 10% refer to abandoned ponds. The results reached by this preliminary analysis show an urgent need for EU regulations regarding technical standards of tailings disposal.
66(4): 391-400	Local, short-term dispersal by the U.S. federally-threatened leopard darter, Percina pantherina, was examined in the field and in the laboratory to assess the possible effects of natural versus man-made barriers on movement. Mark-resight studies were conducted in two summers at sites in the Glover River (southeastern Oklahoma, U.S.A.). At one site, patches of 'preferred' habitat were separated by a natural riffle; at the other site, by a low-water road crossing with culverts. At the natural riffle site, darters moved downstream across the riffle, but also moved upstream into deeper water when water temperatures exceeded 29° C in the 'preferred' habitat. Use of deeper, cooler waters by this species in late summer suggests that thermal refugia may be important habitats for the long-term management of leopard darters. At the Road Crossing site, all documented movement was in a downstream direction, and at least two darters traversed culverts in the low-water bridge. Laboratory studies of movement across several types of culverts suggested that culverts significantly decrease the probability of movement among habitat patches.
N/a	None
14(4): 969-974	Although excessive loading of fine sediments into rivers is well known to degrade salmonid spawning habitat, its effects on rearing juveniles have been unclear. We experimentally manipulated fine bed sediment in a northern California river and examined responses of juvenile salmonids and the food webs supporting them. Increasing concentrations of deposited fine sediment decreased growth and survival of juvenile steelhead trout. These declines were associated with a shift in invertebrates toward burrowing taxa unavailable as prey and with increased steelhead activity and injury at higher levels of fine sediment. The linear relationship between deposited fine sediment and juvenile steelhead growth suggests that there is no threshold below which exacerbation of fine-sediment delivery and storage in gravel bedded rivers will be harmless, but also that any reduction could produce immediate benefits for salmonid restoration.

127: 637-344	We used mark–recapture techniques to examine the effects of four types of road crossings on fish movement during spring base flows and summer low flows in small streams of the Ouachita Mountains, west-central Arkansas. We assessed movement for 21 fish species in seven families through culvert, slab, open-box, and ford crossings and through natural reaches. We detected no seasonal or directional bias in fish movement through any crossing type or the natural reaches. Overall fish movement was an order of magnitude lower through culverts than through other crossings or natural reaches, except no movement was detected through the slab crossing. In contrast, open-box and ford crossings showed little difference from natural reaches in overall movement of fishes. Numbers of species that traversed crossings and movement within three of four dominant fish families (Centrarchidae, Cyprinidae, and Fundulidae) also were reduced at culverts relative to ford and open-box crossings and natural reaches. In spring, retention of fishes was consistently highest in stream segments upstream of crossings and lowest in downstream segments for all crossing types, a response attributed to scouring associated with spring spates. Water velocity at crossings was inversely related to fish movement; culvert crossings consistently had the highest velocities and open-box crossings had the lowest. A key requirement for improving road crossing designs for small-stream fish passage will be determination of critical levels of water velocity through crossings.
3(1): 1-6	Total dissolves solids (TDS) are naturally present in water or are the result of mining or some industrial treatment of water. TDS contain minerals and organic molecules that provide benefits such as nutrients or contaminants such as toxic metals and organic pollutants. Current regulations require the periodic monitoring of TDS, which is a measurement of inorganic salts, organic matter and other dissolved materials in water. Measurements of TDS do not differentiate among ions. The amount of TDS in a water sample is measured by filtering the sample through a 2.0 µm pore size filter, evaporating the remaining filtrate and then drying what is left to a constant weight at 180°C. The concentration and composition of TDS in natural waters is determined by the geology of the drainage, atmospheric precipitation and the water balance (evaporation-precipitation). The mean salinity of the world's rivers is approximately 120 mg/L and the major anion found in natural waters is bicarbonate. The most commonly occurring cation in fresh water is calcium. Changes in TDS concentrations in natural waters often result from industrial effluent, changes to the water balance (by limiting inflow, by increased water use or increased precipitation), or by salt-water intrusion. It is recommended that different limits for individual ions, rather than TDS, be used for salmonid species. These limits should be based on the effect of the ion on fertilization and egg development.

4: 513-519	In February 2006, the US Supreme Court heard cases that may affect whether intermittent streams are jurisdictional waters under the Clean Water Act. In June 2006, however, the cases were remanded to the circuit court, leaving the status of intermittent streams uncertain once again. The presence of commercial species, such as coho salmon (*Oncorhynchus kisutch*), can be an important consideration when determining jurisdiction. These salmon spawn in the upper portions of Oregon coastal stream networks, where intermittent streams are common. In our study of a coastal Oregon watershed, we found that intermittent streams were an important source of coho salmon smolts. Residual pools in intermittent streams provided a means by which juvenile coho could survive during dry periods; smolts that overwintered in intermittent streams were larger than those from perennial streams. Movement of juvenile coho into intermittent tributaries from the mainstem was another way in which the fish exploited the habitat and illustrates the importance of maintaining accessibility for entire stream networks. Loss of intermittent stream habitat would have a negative effect on coho salmon populations in coastal drainages, including downstream navigable waters.
120: 98-105	A spatially intensive survey in 1989 of 52 sites in the Red River drainage in southwest Oklahoma and surveys in all years from 1978 to 1987 on four sites in the drainage provided evidence that construction of Altus Dam on the North Fork of the Red River caused major changes in fish community structure in the river above the dam. Pre-impoundment data on the fish communities were scanty, but the inferences they allowed were similar to those obtained by comparing fish assemblages in the North Fork above the dam with assemblages elsewhere in the drainage, particularly along Salt Fork, which had similar habitat characteristics. Twenty-five species were collected in the North Fork above Altus Dam, compared to 33 in the Salt Fork and 34 in the North Fork below the dam. The speckled chub *Macrhybopsis* (formerly *Hybopsis*) *aestivalis* and the chub shiner *Notropis potteri* were absent in the North Fork above Altus Dam but fairly common in similar streams elsewhere in the area. The plains minnow *Hybognathus placitus* and the Red River shiner *Notropis bairdi* were among the most common fish species found in southwest Oklahoma, but were not collected above Altus Dam in the 1989 survey and were collected only intermittently and in small numbers in the long-term survey. We speculate that these two species have repeatedly been extirpated and have been reestablished as bait-bucket introductions since the dam was closed. Upstream of the reservoir, the sand shiner *Notropis stramineus* and the emerald shiner *Notropis atherinoides* replaced the plains minnow and the Red River shiner as dominant species, and several reservoir species were more common. Significant negative association at two long-term sites suggested that the sand shiner and Red River shiner were filling similar niches.

126(4): 699-706	The South Fork basin of the Coeur d'Alene River, Idaho, has been an area of heavy mining activity since the 1880s. The mining operations have resulted in elevated concentrations of metals in surface water, most notably cadmium, lead, zinc, and, to a lesser extent, copper. The metals affected surface water quality downstream in the Coeur d'Alene basin and are suspected to be one of the primary reasons for the reduction in populations of native westslope cutthroat trout Oncorhynchus clarki lewisi. The avoidance response of a surrogate species, Snake River cutthroat trout O. clarki (unnamed subspecies), was evaluated against conditions simulating those in the Coeur d'Alene River basin. Cutthroat trout avoided a metals mixture of these concentrations: Cd (0.30 µg/L), Cu (6.0 µg/L), Pb (0.6 µg/L), and Zn (28 µg/L). The avoidance response to either Cu or Zn alone was similar to the avoidance response to the mixture, suggesting that avoidance to the mixture was due to these metals. After acclimation to Zn at 55 µg/L for 90 d, cutthroat trout detected and preferred a lower Zn concentration of 28 µg/L. The lowest Zn concentrations avoided (28 µg/L) were 1/6 to 1/78 the Zn concentrations measured in the South Fork and lower Coeur d'Alene River basins. Avoidance of metals-contaminated habitats by cutthroat trout may be, in part, responsible for reduced fish populations.
48	Combined stream survey data for 2008 - 2010 indicated salmon presence in 3 of every 4 headwater streams of less than 10% gradient draining to an anadromous river, including streams on top of the Pebble Prospect. Rearing salmon were documented above dry stream reaches and in waters disconnected from rivers suggesting salmon access such sites during annual floods or via subsurface groundwater channels. Non-salmon species important to subsistence, such as Dolly Varden char, were found in 96% of streams surveyed. A total of 168 km (104.3 miles) of previously undocumented salmon streams, were nominated for the first time to the State's Anadromous Water Catalog. The State accepted all 2008 and 2009 new salmon stream nominations, available at (http://www.sf.adfg.state.ak.us/SARR/AWC/index.cfm) and 2010 nominations are currently under review. Aerial survey data verified adult salmon presence in an additional 358 km (253 miles) of streams and rivers that needed confirming data. This study underscores both the importance of headwater streams as essential rearing habitat for salmon and the lack of basic ecological information for two of the world's most productive salmon systems, the Nushagak and Kvichak River watersheds.
59(5): 1023-1031	Environmental impacts of acid mine drainage (AMD) from Dexing Copper Mine, the largest open pit copper mine in Asia, on Le An River were well documented 10 years ago. However, ore production of the mine has increased fourfold and the contamination situation of the river now is unknown. Our studies indicated that heavy metal concentrations in riverwaters (dissolved), suspended solids (SS) and sediments all showed highly localized distribution patterns closely associated with two AMD-contaminated tributaries (Dawu River and Ji River) and are significantly different from the previous findings. Compared with the previous reports, most of the sampling sites in Le An River displayed lower contents of sediments of 2005 because several historical upstream and downstream heavy metal sources disappeared or became unimportant. The surprised decrease of copper contents in sediments at the mixing location with Dawu River was mainly due to dilution from the sufficient input of poor copper ore (<0.3%).

N/a	None
76	The scope of this report is limited to assessment and analysis of chemical reactions related to drilling and seismic surveys that have the potential to impact water resources. In general, contamination of surface water may occur through: fuel spills from drills and water pumps, surface discharge of drilling fluids, breakdown products of drilling chemicals, chemical reactions with drill cuttings, and ammonia from seismic charges. Contamination of groundwater may occur through: introduction of grout, clay, fuel, and drilling additives into holes and wells; improper closure of drill holes, particularly in sulfidic host rock; direct infiltration of drilling chemicals and drill cutting metals from unlined mud pits excavated within or in immediate proximity to shallow aquifers.

Annotation	404(c) Categ
	Muncipal water supplies
None	
None	

None	
None	

None	
None	
Addresses the impacts of roads to salmonid rivers in headwater streams.	
None	

None	
None	

None	
None	
None	
None	

None	
The article reviews data on mining waste generated from active and inactive mining sites in the western U.S. The review revealed that in nine states over 2,500 miles of surface waterways were impacted by AMD. Of this total area, approximately 85 percent was attributed to copper, iron ore, uranium, and phosphate mining activities. Approximately one-half of the waste generated was mining rock waste and one-third was tailings, with the balance consisting of dump/heap leaching wastes and mine water.	
None	

None	
None	

None	
None	
None	

None	
None	
None	

None	

None	

None	

Addresses the impacts of roads to salmonid systems including extirpation of salmon resulting from low genetic diversity caused by roads crossing salmonid streams.	
None	

This article is frequently cited with regard to fish avoidance of culverts installed as part of road construction.	
This study reviews the history and accuracy of water quality predictions for major hardrock mines in the United States by comparing actual water quality to the predictions made in Environmental Impact Statements (EISs) and subsequently identifying common causes of water quality impact and prediction failures. In addition, an analysis was conducted to determine if there were inherent risk factors at mines that may predispose an operation to having water quality problems. Of mines analyzed, 76% had mining-related water quality exceedances in surface or groundwater. Eighty-nine percent of mines with acid drainage predicted low acid drainage potential prior to development. Conclusions are provided about the effectiveness of the underlying scientific and engineering principles used to make water quality predictions in EISs. Finally, recommendations are made for regulatory, scientific and engineering approaches that would improve the reliability of water quality predictions at hardrock mine sites. The document may be downloaded at the following website: http://www.mineralpolicy.org/publications_welcome.cfm. For the mines in their study that developed acid drainage, almost all either underestimated or ignored the potential for acid drainage in their EISs. In terms of predicted (post-mitigation) surface water quality impacts, 73% of the mines in their study having surface water quality impacts predicted low water quality impacts in their initial EISs, two predicted moderate impacts, and two had no information on post- mitigation impacts to surface water resources.	Yes
None	

None	
None	
None	

None	
None	

Indicates the area surroudning the deposit possesses low buffering capacity and high potential for acid mine drainage.	
Pages A-64 - A-109 describe impact of non-harvest human activites to salmon fisheries including mining, road building, dam building, water withdrawal, sedimentation, etc. The report states that mining in waters, riparian areas, or flood plains of streams containing or influencing salmon spawning and rearing habitats should be avoided.	
The article discusses the importance of tributary and groundwater temperatures and interconnection in maintaining water temperatures critical to salmonid growth.	

The article provided a detailed search and re-evaluation of the known historical cases of tailings dam failures world-wide. Their review of the dam failure databases (i.e., International Commission on Large Dams [ICOLD], U.S. Commission on Large Dams [USCOLD], USEPA and UN Environmental Program) revealed that 147 cases of world-wide tailings dam disasters have occurred. In Europe, the most prevalent of the 15 different failure causes was associated with unusually high rain events. They also noted that failures attributed to weather events (including rainfall, hurricanes, rapid snowmelt and ice accumulation in tailings dam) may also be associated with overflow/overtopping, seepage, foundation failure or bad impoundment management. Outside of Europe, seismic liquefaction ranked as the second cause of tailings dam failure. They noted that over 90% of the incidents occurred in active mines.	
Highlights the risk factors to fish migration of culverts associated with road construction	
None	
None	

None	
None	

None	
Highlights potential risks to fisheries from road and dam construction	

None	
None	
None	

None	Yes
None	

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
					Yes	
	Yes				Yes	
	Yes				Yes	

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				Yes	Yes	

	Yes				Yes	
	Yes				Yes	
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					Yes	
					Yes	
	Yes				Yes	

	Yes			Yes	Yes	
					Yes	

					Yes	Yes
	Yes				Yes	
	Yes				Yes	

	Yes				Yes	Yes
					Yes	Yes
	Yes				Yes	

	Yes	Yes	Yes		Yes	

					Yes	

					Yes	

	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
	Yes		Yes		Yes	
				Yes	Yes	

	Yes				Yes	
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	Yes				Yes	
	Yes				Yes	

					Yes	
		Yes			Yes	
				Yes	Yes	
	Yes				Yes	

	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
	Yes				Yes	

	Yes				Yes	
	Yes				Yes	
					Yes	

	Yes			Yes	Yes	
				Yes	Yes	

Filename	Keywords (if provided by author/s)
Baldigo_Lawrence_2000.pdf	
Baldwin_et_al_2003.pdf	

Barry_et_al_2000.pdf	
Bash_et_al_2001.pdf	

Beltman_et_al_1999.pdf	Invertebrates, Metals, Accumulation, Community effects
Berg_Northcote_1985.pdf	
Bisson_Bilby_1983.pdf	
Bolliet_et_al_2005.pdf	

Borden_2001.pdf	
Chambers_2007.pdf	

Crouse_et_al_1981.pdf	
Dallinger_et_al_1987.pdf	Fish, Food, Heavy metal, Food chain effect
Davies_2002.pdf	
Davis_et_al_2000.pdf	sediment pollution, massive sulfides, phosphate, open-pit mining, estuary

Dudka_Adriano_1997.pdf	
Durkin_Herrmann_1994.pdf	
Eaton_Scheller_1996.pdf	

Ecology_and_Environment_Inc_2010.pdf	
Espana_et_al_2009.pdf	Acid mine drainage, Double-diffusive convection, Geochemistry, Meromixis, Pit lake, Spain

Fahrig_Merriam_1985.pdf	
Farag_et_al_2003.pdf	
Goldstein_et_al_1999.pdf	

Gresh_et_al_2000.pdf	
Hancock_2002.pdf	human impacts, hyporheic zone, mining impacts, agricultural impacts, urban impacts, industrial pollution, river regulation, sedimentation, stream restoration, stream management
Hansen_et_al_1999.pdf	

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Heikkinen_et_al_2009.pdf	seepage waters, drainage waters, tailings, sulphide mining, heavy metals, As, sulphate, water quality, environmental geochemistry, geochemical modelling, Hitura, Luikonlahti, Finland

Hudson-Edwards_et_al_2003.pdf	

Jackson_2003.pdf	
Kaeser_Sharpe_2001.pdf	

Kemp_et_al_2006.pdf	fish, bypass, dams, avoidance, preference, flow
Kuipers_et_al_2006.pdf	
Lauren_McDonald_1986.pdf	

Malmqvist_Hoffsten_1999.pdf	benthic macroinvertebrates, copper, heavy metals, species richness, streams
Marcus_et_al_2001.pdf	fluvial, flood plains, mining, sediments, Yellowstone Park, contaminants, pollution
Moran_2007.pdf	

This book chapter is not currently included with the bilbliography	
Nordstrom_Alpers_1999.pdf	

NDM_2005e.pdf	
PFMC_1999.pdf	
Poole_et_al_2001.pdf	

Rico_et_al_2008.pdf	Environmental hazards, tailings dam failures, Europe, mine tailings, mono and multivariate statistical analysis
Schaefer_et_al_2003.pdf	habitat, conservation, culverts, percids, fish
This report is not being made available to the public because of “Do Not Cite” restriction from the Pebble Limited Partnership placed on	
Suttle_et_al_2004.pdf	

Warren_Pardew_1998.pdf	
Weber-Scannell_Duffy_2007.pdf	Total Dissolved Solid, TDS, water standards, aquatic organisms, Alaska, salmon

Wigington_et_al_2006.pdf	
Winston_et_al_1991.pdf	

Woodward_et_al_1997.pdf	
Woody_O'Neal_2010.pdf	
Xiao_et_al_20010.pdf	AMD, heavy metals, Dexing Copper Mine, Yinshan lead–zinc mine, Le An River, China

This report is not being made available to the public because of “Do Not Cite” restriction from the Pebble Limited Partnership placed on	
Zamzow_2010.pdf	

Additional notes			

Author	Year	Title	Document Type	Journal/Book Title/Publisher
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Schindler, D.E., P.R. Leavitt, C.S. Brock, S.P. Johnson, and P.D. Quay	2005	Marine-derived nutrients, commercial fisheries, and production of salmon and lake algae in Alaska	Journal Article	Ecology
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Willson, M.F. and K.C. Halupka	1995	Anadromous fish as a keystone species in vertebrate communites	Journal Article	Conservation Biology

Willson, M.F., S.M. Gende, and B.H. Marston	1998	Fishes and the forest: expanding perspectives on fish-wildlife interactions	Journal Article	BioScience

Pages (and Volume(issue) if applicable)	Abstract
443(26): 989-992	Over the past decade, accelerating rates of species extinction have prompted an increasing number of studies to reduce species diversity experimentally and examine how this alters the efficiency by which communities capture resources and convert those into biomass. So far, the generality of patterns and processes observed in individual studies have been the subjects of considerable debate. Here we present a formal meta-analysis of studies that have experimentally manipulated species diversity to examine how it affects the functioning of numerous trophic groups in multiple types of ecosystem. We show that the average effect of decreasing species richness is to decrease the abundance or biomass of the focal trophic group, leading to less complete depletion of resources used by that group. At the same time, analyses reveal that the standing stock of, and resource depletion by, the most species-rich polyculture tends to be no different from that of the single most productive species used in an experiment. Of the known mechanisms that might explain these trends, results are most consistent with what is called the 'sampling effect', which occurs when diverse communities are more likely to contain and become dominated by the most productive species. Whether this mechanism is widespread in natural communities is currently controversial. Patterns we report are remarkably consistent for four different trophic groups (producers, herbivores, detritivores and predators) and two major ecosystem types (aquatic and terrestrial). Collectively, our analyses suggest that the average species loss does indeed affect the functioning of a wide variety of organisms and ecosystems, but the magnitude of these effects is ultimately determined by the identity of species that are going extinct.
24(10): 6-15	Pacific salmon and other anadromous salmonids represent a major vector for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Salmon carcasses provide nutrients and energy to biota within aquatic and terrestrial ecosystems through various pathways. In this paper we review and synthesize the growing number of studies documenting this process in different localities. We also discuss the implications for maintaining the nutrient feedback system. Our findings show that future management will need to view spawning salmon and their carcasses as important habitat components for sustaining the production of fish as well as other salmon-dependent species within watersheds.
24(11): 631-641	None

138: 1207-1219	A large and growing body of literature has documented the transfer of marine-derived nutrients from the ocean to freshwater and riparian systems by semelparous Pacific salmon *Oncorhynchus* spp. The pathways by which these nutrients reach resident fish are often indirect, and the evidence for direct benefits to the resident fish is not always conclusive. However, the consumption of salmon tissue (in one form or another) by resident fish would constitute a direct and efficient pathway for energy transfer. We studied a population of small-bodied, nonanadromous Dolly Varden *Salvelinus malma* feeding on the fry and eggs of sockeye salmon *O. nerka* and blowfly (family Calliphoridae) larvae that had fed on salmon carcasses at a series of spring-fed and otherwise unproductive ponds in southwestern Alaska. The Dolly Varden fed heavily on sockeye salmon fry when available, shifted their diet almost exclusively to eggs after salmon spawning commenced, and then shifted to blowfly larvae toward the end of the season. Dolly Varden large enough to eat eggs moved into ponds where sockeye salmon spawn synchronously with the arrival of the salmon, and Dolly Varden growth rates increased greatly once salmon eggs and blowfly maggots were available. Young-of-the-year Dolly Varden, which were too small to eat eggs and fry, were concentrated in small streams between ponds where fewer sockeye salmon spawn, perhaps to minimize the risk of predation from larger conspecifics. These results indicate the importance of a pulse of salmon-related food resources for this population of resident fish and their adaptations to take advantage of these resources. It is likely that similar dependence occurs in other systems where sockeye salmon produce a suite of temporally predictable energy resources; thus, resident fish may depend on large populations of salmon.
96: 343-366	The study examined two competing hypotheses seeking to explain the Kvichak cycle: (1) existence of a depensatory agent independent of the fishery and (2) depensatory fishing. The first hypothesis was implicit in the status quo harvest policy. Available data were analyzed to evaluate the alternative hypotheses. Little evidence for direct depensatory mortality independent of the fishery was found, however, production was depressed in brood years following large escapement brood years. In addition, the fishery itself was found to be extremely depensatory. A stochastic empirical computer simulation model incorporating processes found in the data analyses was used to examine the consistency of brood year interaction with the depensatory fishing hypothesis and historical cyclic patterns in the Kvichak run. The model predicted weak cyclic patterns in the unexploited run and strong cyclic patterns, consistent with the historical patern, in the run exploited under the status quo harvest policy of cyclic escapement goals. The model was then used to evaluate the alternative harvest policies. There were almost no differences in simulated catches under the status quo and static fixed escapement goal and static rate of exploitation policies. Substantial increases in simulated catch occurred with a dynamic policy of alternate years of high escapments following years of low escapement. This harvest policy can be phased with the cycle of resulting runs based on a forecast of future runs. The study suggested that the present Kvichak sockeye management policy should be altered by reducing the prepeak escapment goal and establishing a second peak cycle run.
66(6): 1762-1768	We constructed a patch dynamics model which can be used to simulate the changing sizes of resident populations in a series of interconnected habitat patches. We applied the model to white-footed mice (*Peromyscus leucopus*) inhabiting patches of forest in an agricultural landscape. The model predicts that mouse populations in isolated woodlots have lower growth rates and are thus more prone to extinction than those in connected woodlots. Field data support this prediction.

52(10): 917-928	Because of the burgeoning interest in salmon, growing indications of their ecological importance, and recent calls for management to consider the role of salmon in aquatic and terrestrial ecosystems (e.g., Larkin and Slaney 1997), we take this opportunity to review what is understood about the function of salmon as key elements of ecological systems. Our objectives are twofold. First, we expand on previous reviews of salmon (Willson et al. 1998, Cederholm et al. 1999) to include recent research that has amplified and modified earlier ideas about the contribution of salmon to ecosystem processes. In doing so, we describe the composition, magnitude, and distribution of marine inputs to freshwater and terrestrial systems via salmon. We use an expanding group of studies pertaining to stream nutrient budgets and salmon physiology to construct a schematic that illustrates salmon-derived products and the pathways by which they enter and are retained in aquatic and terrestrial food webs. We then consider the ecological variation associated with salmonid ecosystems and how this may influence the ecological response to the salmon input. Second, we consider how this variation in ecosystem response may influence management and conservation efforts. We conclude by suggesting new research directions to help fill the gaps in our current understanding of salmonid ecosystems.
69: 379-393	Pacific salmon *Oncorhynchus* spp. play a central role in coastal ecosystems that rim the North Pacific Ocean. Given the ecological, cultural, and economic importance of Pacific salmon, there is great interest in defining the magnitude and frequency of change in these fish stocks. Fisheries scientists, through analyzing harvest records, have demonstrated pronounced salmon production variability. The causes underlying such marked fluctuations are currently debated. Collating harvest records across a broad geographic range over the past ~80 years, fisheries scientists have advanced a plausible argument that climate-induced oceanographic changes explain a significant fraction of the variation in salmon catch records. However, without data that predate the introduction of large-scale human interventions (e.g., commercial harvesting, dams, hatchery releases), it is difficult to isolate the role of climate in shaping fish stock dynamics. Within the past decade, however, we have developed a paleolimnological approach for tracking past sockeye salmon *Oncorhynchus nerka* population abundances, and numerous papers have applied this approach to infer changes in these fish over the past hundreds to thousands of years. Here, we provide an overview of the approach and a synthesis of the work that has been conducted in this field to date. It is clear that numerous sockeye salmon populations have undergone pronounced changes, even prior to human interventions. Furthermore, tracking salmon populations over millennial timescales with paleolimnology has revealed modes of change that were previously never imagined possible. Such long-term perspectives indicate that sockeye salmon is a resilient fish species. We note, however, that when natural environmental changes are compounded by intense human impacts, populations have been particularly susceptible to extirpation.

25(1): 15-21	We used historical cannery records and current escapement and harvest records to estimate historical and current salmon escapement to western North American river systems, in order to determine the biomass and marine-derived nitrogen and phosphorous levels delivered by adult salmon, and the deficits corresponding to the diminished returns of adult salmon over the past century. We have estimated the historic biomass of salmon returning to the Pacific Northwest (Washington, Oregon, Idaho, and California) to be 160-226 million kg. The number of fish now returning to these rivers has a biomass of 11.8-13.7 million kg. These numbers indicate that just 6-7% of the marine-derived nitrogen and phosphorous once delivered to the rivers of the Pacific Northwest is currently reaching those streams. This nutrient deficit may be one indication of ecosystem failure that has contributed to the downward spiral of salmonid abundance and diversity in general, further diminishing the possibility of salmon population recovery to self-sustaining levels.
564	Pacific salmon are an important biological and economic resource of countries of the North Pacific rim. They are also a unique group of fish possessing unusually complex life histories. There are seven species of Pacific salmon, five occuring on both the North American and Asian continents (sockeye, pink, chum, Chinook, and coho) and two (masu and amago) only in Asia. The life cycle of the Pacific salmon begins in the autumn when the adult female deposits eggs that are fertilized in gravel beds in rivers or lakes. The young emerge from the gravel the following spring and will either migrate immediately to salt water or spend one or more years in a river or lake before migrating. Migrations in the ocean are extensive during the feeding and growing phase, covering thousands of kilometres. After one or more years the maturing adults find their way back to their home river, returning to their ancestral breeding grounds to spawn. They die after spawning, and the eggs in the gravel signify the beginning of a new cycle. Upon this theme Pacific salmon have developed many variations, both between as well as within species. Pacific Salmon Life Histories provides detailed descriptions of the different life phases through which each of the seven species passes. Each chapter is written by a scientist who has spent years studying and observing a particular species of salmon. Some of the topics covered are geographic distribution, transplants, freshwater life, ocean life, development, growth, feeding, diet, migration, and spawning behaviour. The text is richly supplemented by numerous maps, illustrations, colour plates, and tables and there is a detailed general index, as well as a useful geographical index. This volume brings together for the first time, and in a comprehensive form, most of the available biological information on the seven species of Pacific salmon. It is an invaluable source of information for students and teachers of biology and fisheries science, people in the fishing and aquaculture industry, and interested laypersons in countries of the North Pacific and elsewhere.

29(6): 763-781	Active exchanges of water and dissolved material between the stream and groundwater in many porous sand- and gravel-bed rivers create a dynamic ecotone called the hyporheic zone. Because it lies between two heavily exploited freshwater resources—rivers and groundwater—the hyporheic zone is vulnerable to impacts coming to it through both of these habitats. This review focuses on the direct and indirect effects of human activity on ecosystem functions of the hyporheic zone. River regulation, mining, agriculture, urban, and industrial activities all have the potential to impair interstitial bacterial and invertebrate biota and disrupt the hydrological connections between the hyporheic zone and stream, groundwater, riparian, and floodplain ecosystems. Until recently, our scientific ignorance of hyporheic processes has perhaps excused the inclusion of this ecotone in river management policy. However, this no longer is the case as we become increasingly aware of the central role that the hyporheic zone plays in the maintenance of water quality and as a habitat and refuge for fauna. To fully understand the impacts of human activity on the hyporheic zone, river managers need to work with scientists to conduct long-term studies over large stretches of river. River rehabilitation and protection strategies need to prevent the degradation of linkages between the hyporheic zone and surrounding habitats while ensuring that it remains isolated from toxicants. Strategies that prevent anthropogenic restriction of exchanges may include the periodic release of environmental flows to flush silt and reoxygenate sediments, maintenance of riparian buffers, effective land use practices, and suitable ground-water and surface water extraction policies.
100(11): 6564-6568	A classic example of a sustainable fishery is that targeting sockeye salmon in Bristol Bay, Alaska, where record catches have occurred during the last 20 years. The stock complex is an amalgamation of several hundred discrete spawning populations. Structured within lake systems, individual populations display diverse life history characteristics and local adaptations to the variation in spawning and rearing habitats. This biocomplexity has enabled the aggregate of populations to sustain its productivity despite major changes in climatic conditions affecting the freshwater and marine environments during the last century. Different geographic and life history components that were minor producers during one climatic regime have dominated during others, emphasizing that the biocomplexity of fish stocks is critical for maintaining their resilience to environmental change.
121(4): 546-550	We quantified the amount, spatial distribution, and importance of salmon *(Oncorhynchus* sp.)-derived nitrogen (N) by brown bears (*Ursus arctos*) on the Kenai Peninsula, Alaska. We tested and confirmed the hypothesis that the stable isotope signature ($\delta15N$) of N in foliage of white spruce (*Picea glauca*) was inversely proportional to the distance from salmon-spawning streams ($r=-0.99$ and $P<0.05$ in two separate watersheds). Locations of radio-collared brown bears, relative to their distance from a stream, were highly correlated with $\delta15N$ depletion of foliage across the same gradient ($r=-0.98$ and -0.96 and $P<0.05$ in the same two separate watersheds). Mean rates of redistribution of salmon-derived N by adult female brown bears were 37.2 ± 2.9 kg/year per bear (range 23.1-56.3), of which 96% (35.7 ± 2.7 kg/year per bear) was excreted in urine, 3% (1.1±0.1 kg/year per bear) was excreted in feces, and <1% (0.3 ± 0.1 kg/year per bear) was retained in the body. On an area basis, salmon-N redistribution rates were as high as 5.1 ± 0.7 mg/sq.-m per year per bear within 500 m of the stream but dropped off greatly with increasing distance. We estimated that 15.5-17.8% of the total N in spruce foliage within 500 m of the stream was derived from salmon. Of that, bears had distributed 83-84%. Thus, brown bears can be an important vector of salmon-derived N into riparian ecosystems, but their effects are highly variable spatially and a function of bear density.

77(2): 395-407	We manipulated, in accord with global-warming predictions, the thermal regime of a permanent first-order stream near Toronto, Ontario, Canada. We examined the effects of a 2-3.5°C water-temperature increase on densities, biomass, species composition, and life histories of resident stream invertebrates. The stream was divided longitudinally at the source into two channels, one control and one experimental, and a before and after (BACI) design was employed such that one pre-manipulation year was followed by 2 yr of the temperature manipulation. Changes in the experimental channel following commencement of the manipulation included: (1) decreased total animal densities, particularly Chironomidae (Diptera); (2) earlier onset of adult insect emergence; (3) increased growth rates and precocious breeding in *Hyalella azteca* (Amphipoda); (4) smaller size at maturity for *Nemoura trispinosa* (Plecoptera) and *H. azteca*; and (5) altered sex ratios for *Lepidostoma vernale* (Trichoptera). These results partially corroborate previous laboratory and field studies. However, variation in the responses of individual target species to the manipulation was unexpected and may have been influenced by the genetic structure of local populations. We conclude that levels of gene flow among habitats may be critical to the degree of impact seen as a result of large-scale thermal perturbation (e.g., global warming).
29(1): 220-244	We summarized studies on the impacts and scale effects of negative (competition, predation, parasitism, herbivory) and positive (mutualism, commensalism, indirect facilitation) species interactions in freshwater benthic habitats since ,1986 and focused on organisms with mainly or entirely aquatic life cycles. Benthologists publishing in J-NABS have contributed robustly to our overall knowledge of predation and herbivory but less so of other species interactions. Predators can limit the abundance of benthic prey and affect prey size or age structure, behavior, and morphology, and these effects can be transmitted through food webs and ecosystems. Herbivores can limit biomass of benthic algae, alter physiognomy, species composition and diversity, and stoichiometry, and exert strong indirect effects within food webs and nutrient cycles. Parasites can alter host behavior or morphology, but few studies have shown that lethal/sublethal effects of parasites on their hosts have population- or community-scale consequences. Fishes and macroinvertebrates occasionally experience competition, but the effect of competition on demographies and assemblages appears restricted to local scales, perhaps because competition can be modulated by many biotic (bioenergetic efficiency, parasitism, predation) and abiotic (floods, drought, resource distribution) factors. Positive interactions have been the least studied species interaction by benthologists, but interest is growing. Future study of population-scale positive interactions and nontraditional interactions at larger scales (e.g., riparian effects on benthic habitat stabilization, cross-system recruitment of different life stages) will improve our understanding of freshwater benthic ecosystems and their conservation. We urge benthologists to explore how populations evolve in response to biotic interactions embedded in benthic communities and to assess how these responses might redefine trophic and community structure and their emergent properties.

113(1): 81-101	Many explanations for diversity patterns have been proposed, and there have been several recent reviews of the subject (Pianka 1966, 1974; Ricklefs 1973; Pielou 1975). High diversity has been attributed both to intense competition which forces niche restriction (Dobzhansky 1950; MacArthur and Wilson 1967) and negatively correlated with productivity (Yount 1956; Margalef 1969). The question is far from settled. This paper develops an approach to the problem of species diversity based on the nonequilibrium interactions of competing populations. Under nonequilibrium conditions, differences in diversity are strongly influenced by variations in the rates of competitive displacement between communities, and such factors as relative competititve abilities, niche partitioning, etc., may not be particularly important. This approach deals primarily with the maintenance of diversity, as opposed to the generation of diversity. While most of the current diversity hypotheses have some relation to the evolutionary origin of diversity, this will not be emphasized here.
93(870): 145-159	None
19: 1-15	None

50: 2350-2365	Biota δ15N and δ13C values (deviations from recognized isotope standards) from Iliamna Lake (a major anadromous sockeye salmon (*Oncorhynchus nerka*) nursery lake supporting peak-year runs >10 million) and several other anadromous-salmon-free lakes in the Kvichak River watershed, Bristol Bay, southwestern Alaska, were compared to determine the significance of marine-derived nitrogen (MDN) delivered by returning adult salmon. Biota in Iliamna Lake had higher δ15N compared with control lakes, verifying a mixing model correlating δ15N with MDN. Periphyton δ15N values reflected localized input from populations of spawning salmon. Juvenile sockeye MDN varied in response to escapement size, suggesting the importance of large escapements (>10 million) for maintaining a predominantly MDN lacustrine N pool. Other resident fishes showed shifts in δ15N between years of high and low escapement. The dual-isotope approach, using δ15N and δ13C together, suggested that fish production is primarily dependent on limnetic primary and secondary production. The dual-isotope approach indicated that the coast range sculpin (*Cottus aleuticus*) was the only fish with an appreciable dietary component consisting of salmon eggs or emergent fry.
721	Sustainable Fisheries Management: Pacific Salmon clearly articulates the current state of the Pacific Salmon resource, describes the key features of its management, and provides important ideas and suggestions on how we can make the transition toward sustainable fisheries. The solutions presented in this book provide the basis of a strategy for sustainable fisheries, requiring society and government agencies to establish a shared vision, common policies, and a process for collaborative management.
23(4): 399-417	Recent progress in the study of aquatic food-cycle relationships invites a re- appraisal of certain ecological tenets. Quantitative productivity data provide a basis for enunciating certain trophic principles, which, when applied to a series of successional stages, shed new light on the dynamics of ecological succession.

5(4): 399-417	Pacific salmon *(Oncorhynchus* spp.) accumulate substantial nutrients in their bodies as they grow to adulthood at sea. These nutrients are carried to predominantly oligotrophic lakes and streams, where they are released during and after spawning. Research over more than 3 decades has shown that the annual deposition of salmon-borne marine-derived nutrients (MD-nutrients) is important for the productivity of freshwater communities throughout the Pacific coastal region. However, the pathways and mechanisms for MD-nutrient transfer and accumulation in freshwater and riparian ecosystems remain virtually unexplored, consequently, there are many uncertainties in this area. This article addresses three related topics. First, we summarize recent advances in our understanding of the linkages among MD-nutrients, freshwater (including riparian) ecosystems, and community dynamics by addressing the importance of MD-nutrients to lakes and streams and by then reviewing large scale and long-term processes in the atmosphere and ocean that govern variability in salmon populations. Second, we evaluate the validity of the discoveries and their implications for active ecosystem management, noting areas where extrapolation from these results still requires great caution. Finally, we outline five key research issues where additional discoveries could greatly augment our understanding of the processes shaping the structure and dynamics of salmon populations and the characteristics of their freshwater habitat and associated riparian zones. Collectively, the data suggest that the freshwater portion of the salmon production system is intimately linked to the ocean. Moreover, for the system to be sustainable, a holistic approach to management will be required. This holistic approach will need to treat climate cycles, salmon, riparian vegetation, predators, and MD-nutrient flowpaths and feedbacks as an integrated system.
16(2): 4-21	The American Fisheries Society herein provides a list of depleted Pacific salmon, steelhead, and sea-run cutthroat stocks from California, Oregon, Idaho, and Washington, to accompany the list of rare inland fishes reported by Williams et al. (1989). The list includes 214 native naturally spawning stocks: 101 at high risk of extinction, 58 at moderate risk of extinction, 54 of special concern, and one classified as threatened under the Endangered Species Act of 1973 and as endangered by the state of California. The decline in native salmon, steelhead, and sea-run cutthroat populations has resulted from habitat loss and damage, and inadequate passage and flows caused by hydropower, agriculture, logging, and other developments; overfishing, primarily of weaker stocks in mixed-stock fisheries; and negative interactions with other fishes, including nonnative hatchery salmon and steelhead. While some attempts at remedying these threats have been made, they have not been enough to prevent the broad decline of stocks along the West Coast. A new paradigm that advances habitat restoration and ecosystem function rather than hatchery production is needed for many of these stocks to survive and prosper into the next century.
27(1): 55-112	None

47(1): 769	None
24: 1018-1031	We develop and illustrate the concept of 'hydrologic spiralling' using a high-resolution (2x2m grid cell) simulation of hyporheic hydrology across a 1.7 km^2 section of the sand, gravel and cobble floodplain aquifer of the upper Umatilla River of northeastern Oregon, USA. We parameterized the model using a continuous map of surface water stage derived from LIDAR remote sensing data. Model results reveal the presence of complex spatial patterns of hyporheic exchange across spatial scales. We use simulation results to describe streams as a collection of hierarchically organized, individual flow paths that spiral across ecotones within streams and knit together stream ecosystems. Such a view underscores the importance of: (1) gross hyporheic exchange rates in rivers, (2) the differing ecological roles of short and long hyporheic flow paths, and (3) the downstream movement of water and solutes outside of the stream channel (e.g. in the alluvial aquifer). Hydrologic spirals underscore important limitations of empirical measures of biotic solute uptake from streams and provide a needed hydrologic framework for emerging research foci in stream ecology such as hydrologic connectivity, spatial and temporal variation in biogeochemical cycling rates and the role of stream geomorphology as a dominant control on stream ecosystem dynamics.
13(3): 401-422	Fishes inhabiting streams and rivers in the interior of North America experience a continental climate. Water temperatures reach 0°C in winter and are high in summer. There is a marked seasonal cycle in discharge. These circumstances make groundwater a crucial component of river habitats. Groundwater can influence the distribution, reproductive success, biomass and productivity, behaviour and movements of fishes, and is especially important in winter and summer. Winter flows are minimal and are affected by ice. In winter, the importance of groundwater increases northwards. Groundwater provides overwintering habitat free of subsurface ice and fish may migrate long distances to take advantage of it. The melt season can account for up to half the annual discharge. In summer, groundwater is important for maintaining discharge and moderating stream temperatures. During critically hot weather, groundwater refugia protect species exposed to temperatures approaching their thermal limits. Since groundwater exerts such an important influence on river habitats, its quality, quantity and sustainability should be considered before development proposals are approved which could alter it. Examples of the role of groundwater in the ecology of some species show how localised and critical habitats influenced by groundwater can be, and, in consequence, how necessary it is to protect them. Protection is complicated because groundwater distribution pathways are often unknown and recharge areas may be remote from discharges. Scale becomes important in identifying potential risks to critical stream habitats from all types of landscape modification and water abstraction. Groundwater temperatures reflect mean annual air temperatures and are likely to change as global climates respond to increases in the greenhouse gases in the atmosphere. This could profoundly change critical fish habitats, particularly those at the margins of species distributions or those that are already overcrowded. Such considerations emphasise the importance of developing proper strategies for the conservation of groundwater.

24: 391-411	Salmonids spawn in highly diverse habitats, exhibit strong genetic population structuring, and can quickly colonize newly created habitats with few founders. Spawning traits often differ among populations, but it is largely unknown if these differences are adaptive or due to genetic drift. To test if sockeye salmon (*Oncorhynchus nerka*) populations are adapted to glacial, beach, and tributary spawning habitats, we examined variation in heritable phenotypic traits associated with spawning in 13 populations of wild sockeye salmon in Lake Clark, Alaska. These populations were commonly founded between 100 and 400 hundred sockeye salmon generations ago and exhibit low genetic divergence at 11 microsatellite loci (F_{ST}\0.024) that is uncorrelated with spawning habitat type. We found that mean P_{ST} (phenotypic divergence among populations) exceeded neutral F_{ST} for most phenotypic traits measured, indicating that phenotypic differences among populations could not be explained by genetic drift alone. Phenotypic divergence among populations was associated with spawning habitat differences, but not with neutral genetic divergence. For example, female body color was lighter and egg color was darker in glacial than non-glacial habitats. This may be due to reduced sexual selection for red spawning color in glacial habitats and an apparent trade-off in carotenoid allocation to body and egg color in females. Phenotypic plasticity is an unlikely source of phenotypic differences because Lake Clark sockeye salmon spend nearly all their lives in a common environment. Our data suggest that Lake Clark sockeye salmon populations are adapted to spawning in glacial, beach and tributary habitats and provide the first evidence of a glacial spawning ecotype in salmonids.
1(1): 31-37	One of the most spectacular phenomena in nature is the annual return of millions of salmon to spawn in their natal streams and lakes along the Pacific coast of North America. The salmon die after spawning, and the nutrients and energy in their bodies, derived almost entirely from marine sources, are deposited in the freshwater ecosystems. This represents a vital input to the ecosystems used as spawning grounds. Salmon-derived nutrients make up a substantial fraction of the plants and animals in aquatic and terrestrial habitats associated with healthy salmon populations. The decline of salmon numbers throughout much of their southern range in North America has prompted concern that the elimination of this "conveyor belt" of nutrients and energy may fundamentally change the productivity of these coastal freshwater and terrestrial ecosystems, and consequently their ability to support wildlife, including salmon. If progress is to be made towards understanding and conserving the connection between migratory salmon and coastal ecosystems, scientists and decision-makers must explore and understand the vast temporal and spatial scales that characterize this relationship.

86(12): 3225-3231	For decades ecologists have recognized the potential importance of marine derived nutrients (MDN) deposited in freshwater ecosystems by spawning anadromous salmon. Previous studies have shown that some MDN are retained in freshwater ecosystems. A popular hypothesis linking MDN to salmon population productivity posits that MDN provided by post-spawning mortality of salmon are critical for salmon population dynamics because they enhance prey populations in the freshwater ecosystems used as nursery habitats. We tested this hypothesis by reconstructing historical sockeye salmon populations for the last 300 years in Bristol Bay, Alaska. Stable nitrogen isotope chronologies in lake sediments and sockeye catch and escapement histories show that commercial fisheries intercepted about two-thirds of MDN bound for freshwater spawning grounds since about 1900. Reconstruction of lake algal production using fossil pigments shows that this loss of MDN has reduced lake algal productivity to about one-third of its level before commercial fishing. However, contrary to expectation, recent sockeye population sizes (sum of spawning escapement and fishery catch) in the last century were equivalent to those before the advent of commercial fishing. These data demonstrate that the MDN subsidy is important for the productivity of coastal lakes but that some sockeye salmon populations are limited by other features of ecosystems such as the amount of suitable spawning habitat.
465: 609-612	One of the most pervasive themes in ecology is that biological diversity stabilizes ecosystem processes and the services they provide to society, a concept that has become a common argument for biodiversity conservation. Species-rich communities are thought to produce more temporally stable ecosystem services because of the complementary or independent dynamics among species that perform similar ecosystem functions. Such variance dampening within communities is referred to as a portfolio effect and is analogous to the effects of asset diversity on the stability of financial portfolios. In ecology, these arguments have focused on the effects of species diversity on ecosystem stability but have not considered the importance of biologically relevant diversity within individual species. Current rates of population extirpation are probably at least three orders of magnitude higher than species extinction rates, so there is a pressing need to clarify how population and life history diversity affect the performance of individual species in providing important ecosystem services. Here we use five decades of data from *Oncorhynchus nerka* (sockeye salmon) in Bristol Bay, Alaska, to provide the first quantification of portfolio effects that derive from population and life history diversity in an important and heavily exploited species. Variability in annual Bristol Bay salmon returns is 2.2 times lower than it would be if the system consisted of a single homogenous population rather than the several hundred discrete populations it currently consists of. Furthermore, if it were a single homogeneous population, such increased variability would lead to ten times more frequent fisheries closures. Portfolio effects are also evident in watershed food webs, where they stabilize and extend predator access to salmon resources. Our results demonstrate the critical importance of maintaining population diversity for stabilizing ecosystem services and securing the economies and livelihoods that depend on them. The reliability of ecosystem services will erode faster than indicated by species loss alone.

8(4): 297-314	Salmonids are an important component of biodiversity, culture and economy in several regions, particularly the North Pacific Rim. Given this importance, they have been intensively studied for about a century, and the pioneering scientists recognized the critical link between population structure and conservation. Spatial structure is indeed of prime importance for salmon conservation and management. At first glance, the essence of the metapopulation concept, i.e., a population of populations, widely used on other organisms like butterflies, seems to be particularly relevant to salmon, and more generally to anadromous fish. Nevertheless, the concept is rarely used, and barely tested. Here, we present a metapopulation perspective for anadromous fish, assessing in terms of processes rather than of patterns the set of necessary conditions for metapopulation dynamics to exist. Salmon, and particularly sockeye salmon in Alaska, are used as an illustrative case study. A review of life history traits indicates that the three basic conditions are likely to be fulfilled by anadromous salmon: (i) the spawning habitat is discrete and populations are spatially separated by unsuitable habitat; (ii) some asynchrony is present in the dynamics of more or less distant populations and (iii) dispersal links populations because some salmon stray from their natal population. The implications of some peculiarities of salmon life history traits, unusual in classical metapopulations, are also discussed. Deeper understanding of the population structure of anadromous fish will be advanced by future studies on specific topics: (i) criteria must be defined for the delineation of suitable habitats that are based on features of the biotope and not on the presence of fish; (ii) the collection of long-term data and the development of improved methods to determine age structure are essential for correctly estimating levels of asynchrony between populations and (iii) several key aspects of dispersal are still poorly understood and need to be examined in detail: the spatial and temporal scales of dispersal movements, the origin and destination populations instead of simple straying rates, and the relative reproductive success of immigrants and residents.
46(2): 336-365	None

67(1): 77-85	Salmonid fishes aggregate for breeding at spatially defined, suitable habitats. These aggregations may evolve into discrete populations when precise natal homing leads to reproductive isolation, and local regimes of selection lead to adaptation. Population structure is often defined by persistent differences in selectively neutral genetic markers and in mean values of morphological and life-history traits between locations. This approach is limited by the spatial scale at which traits diverge; low levels of reproductively successful straying, combined with similar selective pressures on life-history traits resulting from similar habitat features and environmental conditions, can significantly reduce the power of these discriminatory methods. We compared data on three life-history traits and polymorphism of DNA microsatellites for evidence of population subdivision among sockeye salmon spawning on spatially discrete but physically similar beaches on islands in Iliamna Lake, Alaska. We found small but significant differences in average body length, body depth and age composition between sites as well as significant interactions between site and year. These interactions, reflecting random variation in growth or recruitment among sites, are a powerful tool for discriminating populations with similar mean trait values. These results suggest fine-scale homing to natal sites, but the microsatellite data revealed no evidence of restricted gene flow among sites. There seems to be enough straying among the populations to prevent differentiation at neutral traits but enough homing for them to be functionally distinct.
37: 130-137	From headwaters to mouth, the physical variables within a river system present a continuous gradient of physical conditions. This gradient should elicit a series of responses within the constituent populations resulting in a continuum of biotic adjustments and consistent patterns of loading, transport, utilization, and storage of organic matter along the length of a river. Based on the energy equilibrium theory of fluvial geomorphologists, we hypothesize that the structural and functional characteristics of stream communities are adapted to conform to the most probable position or mean state of the physical system. We reason that producer and consumer communities characteristic of a given river reach become established in harmony with the dynamic physical conditions of the channel. In natural stream systems, biological communities can be characterized as forming a temporal continuum of synchronized species replacements. This continuous replacement functions to distribute the utilization of energy inputs over time. Thus, the biological system moves towards a balance between a tendency for efficient use of energy inputs through resource partitioning (food, substrate, etc.) and an opposing tendency for a uniform rate of energy processing throughout the year. We theorize that biological communities developed in natural streams assume processing strategies involving minimum energy loss. Downstream communities are fashioned to capitalize on upstream processing inefficiencies. Both the upstream inefficiency (leakage) and the downstream adjustments seem predictable. We propose that this River Continuum Concept provides a framework for integrating predictable and observable biological features of lotic systems. Implications of the concept in the areas of structure, function, and stability of riverine ecosystems are discussed.

8(1): 2-8	The dynamic and hierarchical nature of lotic ecosystems may be conceptualized in a four-dimensional framework. Upstream-downstream interactions constitute the longitudinal dimension. The lateral dimension includes interactions between the channel and riparian/floodplain systems. Significant interactions also occur between the channel and contiguous groundwater, the vertical dimension. The fourth dimension, time, provides the temporal scale. Lotic ecosystems have developed in response to dynamic patterns and processes occurring along these four dimensions. An holistic approach that employs a spatio-temporal framework, and that perceives disturbances as forces disrupting major interactive pathways, should lead to a more complete understanding of the dynamic and hierarchical structure of natural and altered lotic ecosystems.
47: 517-539	1. This review is presented as a broad synthesis of riverine landscape diversity, beginning with an account of the variety of landscape elements contained within river corridors. Landscape dynamics within river corridors are then examined in the context of landscape evolution, ecological succession and turnover rates of landscape elements. This is followed by an overview of the role of connectivity and ends with a riverine landscape perspective of biodiversity. 2. River corridors in the natural state are characterised by a diverse array of landscape elements, including surface waters (a gradient of lotic and lentic waterbodies), the fluvial stygoscape (alluvial aquifers), riparian systems (alluvial forests, marshes, meadows) and geomorphic features (bars and islands, ridges and swales, levees and terraces, fans and deltas, fringing floodplains, wood debris deposits and channel networks). 3. Fluvial action (erosion, transport, deposition) is the predominant agent of landscape evolution and also constitutes the natural disturbance regime primarily responsible for sustaining a high level of landscape diversity in river corridors. Although individual landscape features may exhibit high turnover, largely as a function of the interactions between fluvial dynamics and successional phenomena, their relative abundance in the river corridor tends to remain constant over ecological time. 4. Hydrological connectivity, the exchange of matter, energy and biota via the aqueous medium, plays a major though poorly understood role in sustaining riverine landscape diversity. Rigorous investigations of connectivity in diverse river systems should provide considerable insight into landscape-level functional processes. 5. The species pool in riverine landscapes is derived from terrestrial and aquatic communities inhabiting diverse lotic, lentic, riparian and groundwater habitats arrayed across spatio-temporal gradients. Natural disturbance regimes are responsible for both expanding the resource gradient in riverine landscapes as well as for constraining competitive exclusion. 6. Riverine landscapes provide an ideal setting for investigating how complex interactions between disturbance and productivity structure species diversity patterns.
9(3): 489-497	Many wildlife species feed on anadromous fishes of several life-history stages. There is evidence for some wildlife species that the availability of anadromous fish is critically important for survival or reporduction. In some regions anadromous fishes in fresh water appear to be keystone food resources for vertebrate predators and scavengers, forging an ecologically significant link between aquatic and terrestrial ecosystems. The spatial distribution of anadromous fish in fresh water, including the occurrence of runs in very small streams, has important consequences for wildlife biology (social interactions, distribution, activity patterns, possibly survivorship) and conservation of biodiversity.

48(6): 455-462	(From Introduction): Anadromous and inshore-spawning marine fish provide a rich, seasonal food resource that directly affects the biology of both aquatic and terrestrial consumers and indirectly affects the entire food web that knits the water and land together. In addition, the authors suggest that the presence of a seasonally abundant food resource has helped to shape the evolution of aquatic and terrestrial consumers and that predators have proabably exerted reciprocal evolutionary pressures on their prey, potentially influencing the life history and morphology of these fishines. Finally, the authors suggest that anadromous and inshore-spawning fishes constitute such an important prey base for terrestrial wildlife that conventional ecology dogmas need to be revised. Interactions between anadromous fishes and wildlife have been recognized as having some general ecological importance (e.g., Brown 1982), but only recently have the ramifcations of these interactions and their potential magnitude begun to be explored. Because many of the ecological links still need to be described and quantified, the authors concentrate on sketching an outline of the interactions, documenting the effects where possible but also noting effects that seem probable, subject to future research.

Annotation	Muncipal water supplies	404(c) Categ
None		
None		
The basic features of stream ecosystem structure and various functional ecological components and their interrelationships are defined for some representative streams. The article focuses on two general functions of running waters: the efficient conversion of organic matter, especially particulates, to CO_2 and the maintenance of a minor role played by in-stream plant growth. The article ends with a plea to incorporate the 'new stream ecology' into management strategies directed at freshwater resources, suggesting that management at the time the article was written was too anthropocentric.		

The study was conducted in the Pedro Pond complex, a group of ponds connected to the east end of Iliamna Lake near the village of Pedro Bay.	
The paper describes the Kvichak River system as the largest producer of sockeye salmon in Alaska, as well as the history of the Bristol Bay fishing industry and the sockeye runs. Population dynamics of the fishery are modeled, and management alternatives are discussed based on the results.	
None	

In light of the crisis of salmon declines in the Pacific Northwest and the billions of dollars spent unsuccessfully to restore them, the authors review the growing body of literature examining the importance of salmon derived nutrient subsidies to both freshwater and riparian communities. The Bristol Bay region is used to illustrate the magnitude of nutrients imported from the ocean, as much as 5.4×10^7 kg of Nitrogen, 2.7×10^5 kg of Ca, plus other macroelements for a run of 20 million sockeye. Those nutrients disperse as far upstream in freshwater as suitable habitat is accessible, extending the interface between ocean and land. A multitude of species interact with and benefit from those nutrients including bears, insects, birds, benthos, zooplankton, and riparian vegetation. Salmon-derived nutrients increase lake productivity, macroinvertebrate growth, and juvenile salmon growth thereby increasing their survival. Birds associated with riparian habitat are found in greater densities on salmon streams. The carrying capacity of bears increases vastly where salmon are available. Fitness-related variables, including growth rates, litter sizes, and reproductive success, have been attributed to salmon availability for salmon consumers such as eagles, bears, and mustelids, highlighting the importance of salmon to their population dynamics. Management implications of reviewed research is discussed and the authors point out that artificially placing carcasses is not a realistic management decision due to the magnitude of carcasses that would be needed, and stream fertilization does not support the terrestrial environment like salmon. The authors indicate that the preservation of processes related to salmon-derived nutrients is of particular importance.	
The article includes figures and data regarding salmon-derived nitrogen in nursery lakes in Bristol Bay dating back to A.D. 1700 as well as annual catch of western Alaska sockeye salmon.	

None	
A preeminent text on Pacific salmon ecology.	

None	
None	
None	

This article has implications for fisheries in that the species analyzed serve as important forage items for fish. Climate change may reduce forage densities and size.	
None	

None	
This paper explores the reason the earth supports so many kinds of organisms. It focuses attention on problems of species diversity and community organization that have occupied many theoretical and empirical ecologists before and since it was written. It concludes that taxa containing many diversified species will 'evolve' more readily than undiversified taxa, with limits imposed by brain size and 'niche' space; the evolution of biological communities produces complex inter-relationships which increase the stability of the community as a whole; and that smaller organisms exhibit greater diversity than large ones, and thus the evolutionary processes are different for smaller organisms than for large ones. Hutchinson further notes in dealing with human activities, the stability provided by diversity can be valuable even to the most adaptable of all large animals.	
The article arguably serves as the basis of freshwater biogeochemistry. It is one of the first to discuss streams not as isolated systems, but strongly linked to the valleys that they drain in complex chemical and biological relationships. It describes the influence of valley geology as well as vegetation on inorganic chemistry of streams. It discusses the importance of water source, valley slope, soil permeability, and terrestrial vegetation transpiration to streamflow, referred to as a prime ecological factor in streams. It further describes organic inputs driving water chemistry and stream foodwebs and freshwater macroinvertebrates. Finally, the article underlines large effects resulting from anthropogenic activities in stream valleys.	

None	
The text covers needs and values for sustainable fisheries, current Pacific salmon stock status, existing management of Pacific salmon, habitat assessment, artificial (hatchery and net pen) production, modeling approaches to management, habitat protection and restoration, and recommendations for sustainable management.	
From the summary: The article indicates that a biotic community cannot clearly be differentiated from its abiotic environment, referring to the sum total as an 'ecosystem.' Organisms within an ecosystem are grouped into a series of discrete trophic levels, categorized as producers, primary consumers, secondary consumers, etc., each of which is successively dependent upon the preceding level as a source of energy. Producers, however, are directly dependent on solar radiation for energy. The more remote an organism is from solar radiation, the less probability it will be dependent solely upon the preceding trophic level. Quantitative relationships between trophic levels are discussed. The percentage loss of energy due to respiration is progressively greater for higher levels in the food cycle. Consumers at higher trophic levels are progressively more efficient in the use of their food supply. Productivity and efficiency increase during earlier phases of successional development (in lakes, productivity and efficiency increase from oligotrophy to eutrophy). And progressive efficiencies of consumer levels appear to increase throughout the aquatic phases of succession.	

None	
This article does not relate directly to Bristol Bay, but highlights the decline of salmon populations throughout the Pacific Northwest of the United States.	
This study researched the basic workings of stream ecosystems and factors controlling individual, population, and community productivity in a reach of the Silver Spring River in Florida which is heavily influenced by groundwater. Odum characterized the 'biomass pyramid,' measuring ecosystem metabolism by calculating primary productivity, community productivity, and community respiration. He documented a strong positive correlation between visible light and gross primary production, and concluded that Florida's springs have complex and highly adapted ecologies that have maximized the productive use of available energy inputs, particularly sunlight, nutrients, and current velocity.	

The article argues that the natural flow regime of water plays a critical role in sustaining native biodiversity and ecosystem integrity in rivers. It discusses the effects of river exploitation, river management, and development policies. The authors underline the importance of natural streamflow variability in ecosystems and ecological responses to altered flow regimes.	
None	
None	

The article provides evidence for local adaptation of Lake Clark sockeye salmon to glacially turbid spawning streams, such that intensity of visual signals are reduced while weapon size (e.g., snout length and body size) is increased. It concludes that the presence of a glacial ecotype of sockeye salmon suggests that the excellent colonizing ability of the species may be due in part to an ability to adapt quickly to highly unstable, geologically young habitats.	
None	

None	
None	

Bristol Bay is described as largely pristine with only minimal habitat degradation, unaffected by agriculture, logging or dam building, no hatcheries and sustainable fisheries. The paper concludes: Metapopulation dynamics are, by definition, processes occurring on relatively large scales, often much larger that the territory covered by the jurisdiction of a specific management agency. This is particularly true for anadromous fish species because the series of biotopes they need for their different life stages are spread over large areas of land and ocean.	
Taken directly from the conclusion: The multitude of ecological strategies that we observe in nature arise from the evolutionary 'trade-offs' of costs versus benefits in the process of adaptation to habitats. Natural habitats have at least eight quantitative characters (Figures 6-9) and these must be assessed against the organisms own dimensions in space and time. The author suggests that these characters can be condensed into two axes: durational stability, which assesses spatial heterogeneity against time, and resource level and constancy, which expresses the temporal heterogeneity of the same space. Such a two dimensional treatment cannot encapsulate without exception all the complexity of nature, but it will surely be more realistic than attempts to organize ecological strategies along a single dimension. The author concludes that the value of Figure 13 will have to be tested from both the theoretical and the observational viewpoints and it will surely need much modification, and suggests that it demonstrates the necessity of combining all these approaches: theoretical, experimental, and observational.	

The article underscores the importance of genetically distinct sub-populations to the maintenance of the overall strength of Bristol Bay sockeye salmon.	
The article is the first to define the River Continuum Concept.	

None	
None	
None	

Discusses the evolving perspective on the interconnectedness between salmon and other anadromous fish species to other fish, whales, sea lions, and numerous terrestrial predators and scavengers, suggesting that the view that predators reduce fish availability for humans is both one-sided and overly limited.	

404(c) Categories				Other categories		
Shellfish beds	Fishery areas	Wildlife areas	Recreation areas	Site geology/ hydrology	Risk Factors	General ecology
	Yes	Yes				Yes
	Yes	Yes				Yes
	Yes					Yes

	Yes					Yes
	Yes					Yes
					Yes	Yes

	Yes	Yes				Yes
	Yes					Yes

	Yes				Yes	Yes
	Yes					Yes

					Yes	Yes
	Yes					Yes
	Yes	Yes				Yes

	Yes					Yes
						Yes

	Yes	Yes				Yes
	Yes	Yes				Yes
	Yes					Yes

	Yes					Yes
	Yes					Yes
	Yes					Yes

	Yes					Yes
	Yes					Yes
	Yes					Yes

	Yes					Yes
						Yes
	Yes					Yes

	Yes					Yes
	Yes	Yes				Yes

	Yes					Yes
	Yes					Yes

	Yes					Yes
						Yes

	Yes					Yes
	Yes					Yes

						Yes
	Yes					Yes
	Yes	Yes				Yes

	Yes	Yes				Yes

Filename	Keywords (if provided by author/s)
Cardinale_et_al_2006.pdf	
Cederholm_et_al_1999.pdf	
Cummins_1974.pdf	

Denton_et_al_2009.pdf	
Eggers_Rogers_1987.pdf	
Fahrig_Merriam_1985.pdf	

Gende_et_al_2002.pdf	
Gregory-Eaves_et_al_2009.pdf	

Gresh_et_al_2000.pdf	
This book is not included with the bibliography	

Hancock_2002.pdf	human impacts, hyporheic zone, mining impacts, agricultural impacts, urban impacts, industrial pollution, river regulation, sedimentation, stream restoration, stream management
Hilborn_et_al_2003.pdf	
Hilderbrand_et_al_1999.pdf	bear, nitrogen, nutrient flow, salmon, spruce

Hogg_Williams_1996.pdf	
Holomuzki_et_al_2010.pdf	historical review, competition, predation, parasitism, herbivory, positive interactions, indirect interactions, spatiotemporal effects, impact modulators

Huston_1979.pdf	
Hutchinson_1959.pdf	
Hynes_1974.pdf	

Kline_et_al_1993.pdf	
This book is not included with the bibliography	
Lindeman_1942.pdf	

Naiman_et_al_2002.pdf	anadromous fishes, Pacific salmon, *Onchorhynchus,* marine nutrients, stable isotopes, lake, stream, riparian ecosystems, aquatic productivity, resource management
Nehlsen_et_al_1991.pdf	
Odum_1957.pdf	

Poff_et_al_1997.pdf	hydrodynamics, rivers -- environmental aspects, streamflow
Poole_et_al_2008.pdf	hyporheic zone, river, floodplain, groundwater, surface water, biogeochemistry, temperature, aquatic habitat
Power_et_al_1999.pdf	groundwater, river ice, fish habitat, conservation, climate, thermal refugia, northern hydrology, fish movements

Ramstad_et_al_2010.pdf	
Schindler_et_al_2003.pdf	

Schindler_et_al_2005.pdf	biogeochemistry, marine-derived nutrients, mixing model, ^{15}N, paleolimnology, primary production, salmon, salmon enhancement, sediments
Schindler_et_al_2010.pdf	

Schtickzelle_Quinn_2007.pdf	conservation and management, metapopulation dynamics, population structure, salmon, spatial structure, trout
Southwood_1977.pdf	

Stewart_et_al_2003.pdf	
Vannote_et_al_1980.pdf	river continuum, stream ecosystems, ecosystem structure, function, resource partitioning, ecosystem stability, community succession, river zonation, stream geomorphology

Ward_1989.pdf	lotic ecosystems, upstream-downstream linkages, floodplain, groundwater, timescales, spatio-temporal hierarchy
Ward_et_al_2002.pdf	biodiversity, connectivity, floodplains, landscape ecology, natural disturbance
Willson_Halupka_1995.pdf	

Willson_et_al_1998.pdf	

Additional notes